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ETHICAL BASIS OF ATOMIC ENERGY CONTROL

THE debate in the House of Commons on May 14 on the international control of atomic energy added little to what had been said earlier in the House of Lords. Mr. Mayhew, Under-Secretary of State for Foreign Affairs, made it plain that the Government accepts the view that in the present circumstances no progress is possible on the Atomic Energy Commission; but that if a solution of the atomic energy problem could be reached at all, it will be through the machinery of the United Nations. The Government has agreed to the suspension of the discussions for the time being because no effective system of international control is possible without a voluntary merging of some part of national sovereignty. Unlike ten out of the twelve nations represented on the Commission, Soviet Russia, he said, is unwilling to take this step, just as she refuses the complete openness also essential for the success of a scheme of international control.

The most interesting feature of the debate was the reference in Mr. Blackburn's speech, in raising the question, to Sir Edward Appleton's remark on May 13 that there is unlikely to be any final solution to this problem merely along technical lines. Mr. Blackburn added that he does not believe this problem will be solved without a religious revival, which would concentrate the minds and hearts of men upon loftier ideals than the materialistic ends with which we are so often confronted. This sentiment was echoed in other speeches in the debate, and was reflected both in the meeting held in London in the Albert Hall on April 26 to demonstrate the support of the Christian community for the idea of Western union and in other comments on that proposal, and in Mr. Churchill's notable speech at The Hague to the United Europe Congress on May 7.

Mr. Churchill urged that the movement for European unity must be a positive force deriving its strength from our common sense of spiritual values. It is a dynamic expression of democratic faith based upon moral conceptions and inspired by a sense of mission. In the centre of the movement stands a charter of human rights guarded by freedom and sustained by law. Moreover, the movement aims, he said, at the eventual participation of all peoples throughout the Continent of Europe, whose society and way of life are not in disaccord with a charter of human rights and the sincere expression of free democracy.

Mr. Churchill recognized that the world organisation cannot function without the active help of the third great and equal partner, nor can the shadow of war be lifted yet from the hearts and minds of men and nations. Meanwhile, we can create and combine the great regional unities and endeavour to prepare by patient and faithful service for the day when an effective world government will rest on the chief groupings of mankind. This main endeavour can lay the moral and spiritual foundations on which the statesmen of the Western democracies will be able to build the organisation which will achieve freedom from fear—the freedom that matters most to-day.

Mr. Churchill's speech and the Congress itself should do something to foster a return to the confidence in Western democracy and in the personal and spiritual values upon which it rests.

Whatever form Western union may take—and the growth of the movement in the last six months has been remarkable—it represents a real determination among the peoples of Western Europe to preserve and strengthen their free way of life against the threat of Communism; and at the same time, it means not only a belief in the true values of Western civilization but also a knowledge of what Western democracy ought to represent. That implies a task of education as well as readiness to work for the ideal and determination to uphold it against challenge. Only as that task of education proceeds can there be created the volume of informed opinion which will afford not merely the moral support but also the close and understanding criticism which the statesmen of Western Europe will need as they deal with the many thorny problems confronting the working out of concrete proposals for closer union, with the sacrifices in national sovereignty that are involved.

It was a main purpose of the Albert Hall meeting to mobilize Christian effort and Christian faith in Western Europe behind the political, social and economic drive to turn our future into ways of peace and harmony. Material means, as Sir Stafford Cripps said, must be directed by spiritual vision, and the methods used inspired by those great traditions that have been built up in Western Europe through the centuries; and in a message to the meeting, Mr. Churchill asserted that the movement for Western union would come to naught unless the structure of the new Europe was built firmly upon moral and spiritual foundations. The question of atomic energy is only one facet of that problem of building an order in which there is freedom from fear. The report of the commission appointed by the Archbishops of Canterbury and York in 1946 to consider the British Council of Churches report on "The Era of Atomic Power" is, as might be expected, largely concerned with the moral issues which have been so prominent in the movement for Western union; and it indicates very clearly how much there is to be done before we can achieve a common mind on questions of policy which touch spiritual issues, or even make clear precisely what we understand by the moral and spiritual foundations of Western democracy.

The scope of the report is better indicated by its sub-title, "A Study of the Moral and Theological Aspects of Peace and War", than by its title, "The Church and the Atom"*. Indeed, it scarcely touches on the ethical aspects which have so much concerned scientific workers, and which found a place in the B.B.C. talks on atomic energy in March last year. The Commission is, however, somewhat critical of the earlier report, "The Era of Atomic Power", one chapter seeking to correct the work of that Commission by setting atomic warfare in the context of warfare in general and of the doctrine of 'the just war', and to disentangle the moral question from that over-insistence on the divine right of Western democracy which in "The Era of Atomic Power" tended to darken counsel.

What is said in this chapter should be pondered carefully. After setting forth the three accepted grounds or causes of a 'just war', it is observed that if in future the nations agree to establish an international tribunal, the definition of 'just cause' will have to be modified accordingly; the Commission then proceeds to elaborate the Christian tradition that a belligerent should always have as his ultimate end the establishment of peace founded on justice. It insists that there is also a proximate end which is determined by the particular justifying cause, and in this connexion it insists that a belligerent ought not to use more force on the whole than is needed to bring the enemy to terms, and that in the choice of weapons and methods of warfare he should always keep the limited end steadily in view, preferring methods of which the ill-effects are least persistent. A belligerent should do nothing unnecessarily to prejudice the incorporation of his enemy into the community of nations when once the war is ended. In short, the object of warfare is not to kill the enemy, but to disarm and so overpower him.

This is the doctrine by which the validity of strategic bombing and atomic weapons are assessed. The Commission is agreed that the 'obliteration' bombing of whole cities with high-capacity and incendiary bombs must be condemned. It is inconsistent with the limited end of a just war and violates the principles of discrimination just noted: it constitutes an act of wholesale destruction that cannot be justified.

Moral principle thus imposes, in the view of the Commission, considerable restriction on the use of strategic bombing as a means of warfare. Nevertheless, while maintaining that weapons of destruction should only be used in accordance with the moral rules that apply to them, and that these rules cannot be disregarded if the intention is not primarily to destroy but to administer "psychological shock", the Commission does not condemn outright all use of atomic power in war. Refusing to abandon the medieval conception of 'the just war', the majority of the Commission rejects Mr. Henry Stimson's justification of the use of atomic bombs in 1945, but believes that in certain circumstances defensive 'necessity' might justify their use against an unscrupulous aggressor. On the assumption that possession of atomic weapons to-day is genuinely required for national preservation, a Government is entitled to manufacture them and hold them in readiness. Moreover, the Commission considers that if any nation, or any group of nations, which is resolved to resist unscrupulous aggression, lets it be known that it holds itself entitled to defend itself in this way, such warning might go far to prevent the abuse of atomic weapons.

On moral grounds, therefore, the Commission appears to support the opinion that has often been expressed that, in view of Russian intransigence on the vital question of inspection, those nations prepared to make the sacrifice of national sovereignty

* The Church and the Atom: a Study of the Moral and Theological Aspects of Peace and War. Pp. 130. (London: Church Assembly, 1948.) 4s.

should go ahead with such a scheme as has been approved by the majority on the Atomic Energy Commission. Even more pointedly, the Commission observes in its conclusions that the law of Nature requires all peoples to co-operate in promoting a world-order based on justice, and that at present the chief obstacle to such co-operation is found in the quasi-religious convictions and claims made by the U.S.S.R. The duty of fashioning a world-order remains none the less, and the Commission believes that Christians and all who recognize the claims of reason and justice should combine in attempting this work.

Other sections of the report, for all its caution and qualifications, are no less clearly a challenge to thought on the problem of power and its control, and the cultural, political and religious aspects of that problem. The Commission accepts Dr. Toynbee's view that the breakdown of civilizations has been due to internal and not external causes. The task that confronts us to-day is in part, as the movement for Western union recognizes, that of achieving political co-operation and spiritual unity; but it is bound up with the fact that the vast resources of physical and mechanical power which science and technology have put into man's hands can only be developed by the governments of wealthy and highly organised nation-States.

The Commission addresses itself to these questions in its final chapter, "Christian Duty in a World of Power", in which the man of science will find much to weigh and develop. In an earlier chapter, the Commission does not reject as explicitly as some have done the doctrine of neutrality in warfare, though by inference it appears to do so; but it does call for an effort to achieve a fuller understanding of the true order of human purposes which knowledge ought to serve. It upholds the emancipation of science and rejects the suggestion of an arbitrary restriction of scientific research, setting science rather in its true context as one phase of culture. Like the earlier report, "The Era of Atomic Power", it pleads for the achievement of 'wholeness of life', in which all science and all activity are duly subordinated to the knowledge and love of God to cure the fragmentation and distortion of truth caused by excessive specialization.

It is interesting to note the suggestion that science and religion should find their common meeting place not only in the field of reason but also of the imagination. We need to recognize, the Commission urges, far more commonly than we do, the large part played by intuition and imagination in scientific and technological research. Moreover, human society cannot do without the kind of insight and imagination which humane interests and studies alone can give; it is indeed for lack of these that civilization is perishing. The real safeguards against the abuse of knowledge are, in fact, spiritual and educational.

A better balanced education and the breaking down of barriers between the various fields of knowledge are necessary means to the achievement of unity, and the Commission welcomes the foundation of the United Nations Educational, Scientific and Cultural Organisation as evidence that most civilized nations recognize the importance of the cultural factor. It insists, however, that the exclusion of religion from its purview vitiates the work of the Organisation, no less than its failure to recognize the need for a principle of unity in the cultural realm. Once again, in relation to proposals for a world authority or for an effective organisation for the control of atomic energy, the Commission records its conviction that fundamentally the problem of peace is spiritual rather than political.

Here the Commission goes down to fundamentals, and in this respect the report is of more value than the comments now included with the symposium of talks on atomic energy arranged last year by the B.B.C. (see p. 995 of this issue of *Nature*). Mr. N. Loewenstein, it is true, points out that we are still in search of some international code of morality as a substitute for a previous international religious faith, but no other commentator appears to see further than the necessity for some surrender of national sovereignty.

In the talk by Mr. H. A. Wallace with which the book concludes, it is pointed out that there may be no future unless the freedom of man and the peace of the world are preserved. Freedom is essential to science, nor can science come to full fruition except in a world at peace. Science is one of the cultural activities of man, one of the ways in which his creative powers and his questing spirit find expression. For that reason, if for no other, scientific workers cannot stand apart, either from the study of the moral and spiritual aspects of peace and war of which the report "The Church and the Atom" is one expression, or from those movements which, like that for Western union, are bringing about a rebirth of the European spirit and a fresh affirmation of the faith on which European civilization, to which science itself owes so much, has been built. However imperfect may have been the formal resolutions adopted at the Hague Conference, all present realized that the foundation of European unity is not material but spiritual, a common sense of ultimate values transcending all national ideological and religious differences. Science, which in itself makes such an important contribution to cultural unity, cannot but applaud the rebirth of that spirit of unity.

MINERAL RESOURCES OF THE UNITED STATES

Mineral Resources of the United States
By the Staffs of the Bureau of Mines and Geological Survey. Pp. x+212. (Washington, D.C.: Public Affairs Press, 1948.) 5 dollars.

THE pre-eminent industrial position of the United States is based upon her vast mineral resources. In many fields, her production of mineral raw materials exceeds that of any other country, a fact which had an important effect upon the course of the Second World War. The war-time acceleration of production revealed, however, that some branches of the mining industry were not equal to the strain, emphasizing, in addition, that for a few essential

mineral commodities, the United States are necessarily dependent on foreign sources. To meet anxious questionings at the end of the War, a quantitative appraisal of mineral reserves was jointly undertaken by the United States Bureau of Mines and the Geological Survey, these organisations having carried out, with Congressional authority, very extensive investigations for new and marginal sources of supply. The results of the survey were given in evidence before a sub-committee of the Senate Committee on Public Lands, a small edition being published late last year. This does not appear to have been available in Great Britain. The present edition, with the text unchanged, is welcome because it will bring the facts to a wider public; and because the mineral resources of the United States have more than a purely domestic interest.

Owing to the complexity of geological conditions, no assessment of mineral reserves 'in the ground' can be more than an approximation; the available data vary from deposit to deposit and in general become less reliable as the appraiser passes from the single mine to the mining district, and thence to the country as a whole. Estimates of measured (proved) and indicated (probable) reserves must come in the main from industry itself. In highly competitive branches of the mining industry there is a natural reluctance on the part of the companies to divulge their reserves. Assessment of inferred (possible and speculative) ore can best be carried out by government agencies, who are in a better position to see the picture as a whole. The account recognizes frankly the inadequacies of the data but maintains, I think rightly, that within their limitations the figures give a useful picture of the present situation and the possibilities of the immediate future. It is not claimed that they portray the ultimate mineral wealth of the United States.

The overall picture is, on the whole, a favourable one. Thirty-eight mineral products are discussed, with tables, maps and curves of production. Virtual self-sufficiency, even in times of emergency, is assured for a long time in bituminous coal, lignite, anthracite, natural gas, magnesium, molybdenum, metallurgical-grade fluorspar, helium, magnesite, nitrates, phosphates, potash, salt and sulphur. Improvements in technology and economic changes sufficient to bring submarginal reserves into use would add petroleum, aluminium, copper and iron ores to the list. Dependence on foreign sources is confined to chromite, ferro-manganese, nickel, the platinum group metals, tin, diamonds, quartz crystals and asbestos. In the remaining minerals there are partial deficiencies.

Not merely the actual or impending shortages, but also the needs of production lead inevitably to the recognition of the importance of scientifically planned exploration, in which the geologist, geophysicist, geochemist and mining engineer each has his part to play. Behind the technologists there is the dilemma: Should the search be left to private industry, or should it be integrated in a national plan? The authors have no doubt that the latter alternative would give the best results, and it should be remembered that their view is based upon war-time experience of integrated research.

This unique assessment of a nation's mineral resources, valuable to legislators, producers and consumers under a 'free' economy, would appear to have double value in a 'planned' economy. Could such an appraisal be made for British resources? Many of the basic data are in existence. Coal reserves, first estimated by the Royal Commission on Coal Supplies, 1905, are given region by region in the series of regional survey reports published by the Ministry of Fuel and Power during 1945–46. Iron ore reserves have been studied in detail by the Geological Survey and publication is in progress. For the non-ferrous and allied minerals, Geological Survey investigations in collaboration with the war-time Non-Ferrous Development Committee (Ministry of Supply) cover most of the facts. Since the War a Minerals Development Committee (Ministry of Fuel and Power) has been set up. Possibly, however, a more useful picture would be obtained were an attempt made to sum up the resources of the Commonwealth and Empire rather than the reserves of the British Isles alone, considerable as they have been, and great as they still are in some fields.

Estimates of mineral reserves must necessarily have no lasting character. Not only are they affected by extraction as it proceeds, but also they are profoundly influenced by changes in the economic situation, and by improvements in the technology of extraction and recovery. The waste of yesterday becomes the submarginal reserve of to-day and the ore of to-morrow. Perhaps, therefore, any estimate of workable resources is a little more pessimistic than it need be. If, however, it results in a stimulation of scientific effort in the search for new sources and in the development of improved technical methods, it will have served a useful purpose. K. C. DUNHAM

CHEMISTRY FROM THE SCHOOL TO THE UNIVERSITY

Chemistry for Matriculation

By Dr. G. H. Bailey and H. W. Bausor. Fourth edition, revised and rewritten by Dr. Dudley Ridge. Pp. iv + 487. (London: University Tutorial Press, Ltd., 1947.) 7*s.* 6*d.*

Chemistry for Schools

By C. Jenkins and E. H. Foinette. Part 3. Pp. vi + 254. (London and Toronto: William Heinemann, Ltd., 1947.) 4*s.* 6*d.*

Practical Chemistry

By John Lambert and T. A. Muir. Pp. xx + 383. (London: William Heinemann, Ltd., 1947.) 12*s.* 6*d.*

Fundamental Chemistry

An Elementary Textbook for College Classes. By Prof. Horace G. Deming. Second edition. Pp. xvi + 752. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 24*s.* net.

General Chemistry

An Introduction to Descriptive Chemistry and Modern Chemical Theory. By Prof. Linus Pauling. Pp. vii + 595. (San Francisco: W. H. Freeman and Co., 1947.) 4.25 dollars.

Chimie organique

Par Prof. A. Kirrmann. (Collection Armand Colin: Section de chimie, Nos. 246, 247.) 1: Chimie organique générale. Pp. 220. 2: Fonctions simples. Pp. 195. (Paris: Armand Colin, 1947.) 100 francs each vol.

DESPITE the revision by Dr. Ridge, "Chemistry for Matriculation" still gives the impression of being old-fashioned both in content and in presentation, although it will presumably meet the rather limited demand for this type of book. The reviewer believes that no text-book of chemistry can go

through several editions over many years and still retain its initial appeal; after a time it is surely better to write a new book than to over-extend the useful life of the original.

"Chemistry for Schools", by Messrs. Jenkins and Foinette, the last of a trilogy, is intended to cover the final period of a course leading up to the school certificate examinations. To facilitate revision some of the ground covered in earlier volumes is treated again. It is pleasingly produced, and will be readily acceptable to schools where the earlier volumes are in use.

"Practical Chemistry", by Messrs. Lambert and Muir, is designed for students in the latter part of their school certificate course, and throughout their preparation for higher school certificate examinations and the First M.B. examination. To this end the three hundred experiments are divided into six sections. Physical chemistry is treated first, then inorganic chemistry on the basis of the Periodic Table, and organic chemistry subdivided into aliphatic and aromatic divisions. Volumetric analysis, which has previously appeared separately as "The Essentials of Volumetric Analysis", is followed by qualitative analysis based on ionic reactions, with organic reagents introduced for the confirmatory tests, and an introduction to gravimetric analysis. The book is completed by a section on elementary biochemistry. Each experiment is clearly described, together with a brief theoretical explanation, while the apparatus and chemicals required are listed. This book has been carefully compiled from the long experience of the authors, and is well produced. It should meet with ready acceptance as a comprehensive practical book for senior school work.

The two American texts are in pleasing contrast to the first three books, both for the quality of their production and for the refreshingly new approach to the subject. Whereas the former are limited by the school examinations system in Britain and are largely descriptive in character, in the latter much greater attention is paid to the theoretical foundations of the subject. There is no hesitation in introducing the atom and electrons at the earliest stage in a stimulating manner. These two books are introductory texts for a one-year course, and probably would be best used for students meeting the subject for the first time at sixth-form level or as a subsidiary subject at university level. Their prices compare unfavourably with the equivalent British texts, and make it unlikely that they will be widely adopted in Britain. Nevertheless, they can be recommended wholeheartedly to first-year university students.

Prof. Deming's "Fundamental Chemistry" differs from his "General Chemistry" and "Introduction to College Chemistry" in giving fuller treatment of the principles and less space to the historical, cultural and industrial aspects of the subject. In this edition the earlier chapters are simplified by presenting the internal structure of atoms in an elementary way and postponing the details of nuclear chemistry to near the end of the book, when the fission of uranium and plutonium and the creation of synthetic elements is considered. Inorganic complexes and silico-organic compounds are introduced to show that inorganic chemistry is not limited to acids, bases and salts.

Prof. Pauling is known to every university student for his outstanding achievements in theoretical chemistry and their application to problems in inorganic and organic chemistry and biochemistry. He will now reach a younger body of students through his introduction to theoretical and descriptive chemistry. After a discussion of the properties of substances, their atomic and molecular structure, and a survey of descriptive chemistry in relation to the Periodic Table, there are given thorough discussions of weight relations in chemical change, valence and electronic structure, and oxidation-reduction reactions. The first detailed chapter of descriptive chemistry deals with chromium, manganese, and their congeners. These elements are selected for this prominent place for the interest of their chemistry and as excellent examples of oxidation-reduction reactions. The remaining chapters deal with descriptive chemistry and theoretical topics, such as thermo- and radiochemistry. The text gains much from the unconventional diagrams by Roger Hayward, with their emphasis on structural and crystal chemistry.

In the two volumes by Prof. Kirrmann, organic chemistry is presented in pocket form, and the half-hour spent in cutting the pages open is well rewarded. These volumes are recommended to undergraduate chemists who wish to consolidate their knowledge of French. In the first volume general theoretical topics are developed, and the sections on structure and reactions well repay reading. The second volume introduces systematic organic chemistry without the conventional division into aliphatic and aromatic sections, the classification being on the basis of functional groups. The treatment of heterocyclic compounds is less satisfactory, being considered in a separate chapter in rather sketchy fashion. A further volume on multiply functional compounds is promised and will be awaited with interest.

S. H. HARPER

CHEMICAL PROMOTION OF ROOTING IN PLANTS

The Use of Auxins in the Rooting of Woody Cuttings

By Kenneth V. Thimann and Jane Behnke. (Maria Moors Cabot Foundation, Publication No. 1.) Pp. iii + 272. (Petersham, Mass.: Harvard Forest, 1947.) 1 dollar.

IN 1937, the Maria Moors Cabot Foundation was established in the United States to "promote education in the art of increasing the capacity of the earth to sustain human life"; the growth and propagation of trees and other plants as a source of fuel and energy was to be a primary study, and its subsidiary purpose was "to disseminate information helpful and stimulating to others who may wish to enter this field of effort". The book under review, which is the first special publication produced by the Foundation, certainly serves this subsidiary purpose for one of the topics of study in wide-ranging investigations the results of which have been mainly reported in ordinary scientific journals.

Prior to resuming their experiments on vegetative propagation, the authors decided to collect and collate all available published data of a quantitative or semi-quantitative kind on the use of auxins in the promotion of rooting. Gratitude will be felt to them for publishing the results of their labours, which must have been considerable. In the bibliography there are 274 citations—about three times the number in Mitchell and Rice's summary in 1942. The publica-

tions cited report work done up to 1946 in a number of widely scattered countries but mostly in greater America. (The reviewer has failed to find any references to papers published in Scandinavia, France or Italy. Is this because interest in the root-forming powers of chemicals has not yet been aroused in these countries?) Most of the reports are no more than a few pages long. Few of them can be considered as making, by themselves, solid contributions to scientific knowledge; but, read with other texts (for example, the appropriate chapters in Went and Thimann's "Phytohormones" (1937), and in "Hormones and Horticulture" (1947), by Avery *et al.*), the information collectively contained in them, assembled as it has been by Prof. Thimann and Miss Behnke, may well assist in the design of future experiments by plant physiologists who, working on ideas derived from those of Sachs and Beyerinck, seek to unravel the complexities of reacting systems which are competent to produce lateral and adventitious roots.

Up to the present, in this field practical control has outdistanced intellectual control. For the physiologist there may therefore be too little about too much in this book; but gardeners and foresters will find in it a mine of information to guide them in their efforts to establish the conditions which will, with surety, accelerate the rooting of cuttings from ornamental plants or from herbs, shrubs and trees of economic importance. The authors give accounts, ingeniously condensed, of five thousand trials on nearly four hundred genera, with species, varieties and hybrids of *Rhododendron*, *Prunus*, *Pinus*, *Picea*, *Citrus* and *Rosa* among those most used. In these trials, observations have been made of the influence on powers of quick rooting (taking a week or two) or of slow rooting (taking up to a year or more) exerted by one or more of twenty-one synthetic chemicals and sixteen commercial auxins (only one of British manufacture) applied in a variety of ways (basal dipping, coating, etc.) to different kinds of cutting (leafy and leafless softwood or hardwood, leaf, leaf-bud, etc.). Clearly the authors have disseminated much helpful and stimulating information.

M. THOMAS

SERVOMECHANISMS

Theory of Servomechanisms

Edited by Prof. Hubert M. James, Nathaniel B. Nichols and Assoc. Prof. Ralph S. Phillips. (Massachusetts Institute of Technology; Radiation Laboratory Series, No. 25.) Pp. xiv + 375. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 5 dollars.

IT is appropriate that one of the first major works to be published on the theory of servomechanisms is a product of Massachusetts Institute of Technology. The contributions during the past few years of both the M.I.T. Servomechanisms Laboratory and Radiation Laboratory to the theory and practice of automatic control are well known and highly respected by specialists in the subject, and this book, which is volume 25 in the Radiation Laboratory Series, will be welcomed universally. Notwithstanding the fact that there are ten contributing authors, the editors have arranged the mass of new material at their disposal admirably, and continuity in the development of the main ideas is maintained throughout. Several chapters include hitherto unpublished work. For example, a chapter is devoted to the conditions for stability of filter networks and control systems which are actuated by intermittent data; to the reviewer's knowledge no previous quantitative studies of these important systems have been undertaken.

The authors have been influenced in their treatment of the servo problem by modern electric filter design theory and communication engineering techniques. This is no doubt due to the nature of the servo design problem with which they were concerned during the War, namely, the design of automatic following radar equipment. In the development of such equipment the major problem is to minimize the effect of spurious misalignment signals, a problem which is analogous to that of increasing 'signal to noise' ratio in a communications system. An interesting method of dealing with such a situation is described by Prof. Phillips in Chapter 7. If the input 'noise' is assumed to be purely random and optimum performance of the system is assumed when the value of the root mean square error is a minimum, the method shows how optimal values for the control parameters can be obtained without the necessity of deriving the roots of high-degree characteristic equations; the method is illustrated by numerical examples.

The introductory chapter by Prof. Getting is excellent both in its conciseness and quality; it is, in fact, the best short introduction to the basic philosophy of servo system design known to the reviewer. Another valuable feature is the chapter devoted to the study of the behaviour of typical elements used in the design of control systems, such as error measuring devices, servo motors, power amplifiers and gear trains.

The chapter on general design principles introduces the Nyquist stability criterion, the concept of 'equalization' (for example, stabilization) of servo loops, and an elegant application of the attenuation (expressed in decibels) – log frequency and phase – log frequency diagrams to illustrate the frequency response characteristics of a control system and their use in the important problem of controller synthesis. In order to exemplify the power of these new theoretical techniques, a typical radar tracking control system is analysed in detail and, as a second example, the design of a low-power servo system incorporating a two-phase induction motor is discussed.

In view of the authoritative nature of the book it is perhaps somewhat disappointing that it is devoted exclusively to linear systems, especially since it is becoming increasingly clear that non-linear effects such as backlash in gear trains, static friction, saturation of amplifiers, resilience in shafts, etc., constitute the most important factors which limit the performance of modern servo systems. Admittedly, the difficulty of handling such problems is considerable and probably justifies their omission.

A minor criticism concerns the introduction of the problem of designing a manual control system in the last chapter. Despite considerable advances in the design of manual controls, it is unlikely that the transfer function of a human operator will be known with any accuracy for a considerable time to come. The assumption that an operator in tracking a target turns a handwheel at a rate proportional to the error which existed, say, 0·3 sec. previously, cannot be substantiated by experiment and can be misleading.

A. PORTER

Atomic Challenge

A Symposium by Prof. J. D. Cockcroft, Prof. M. L. Oliphant, Group-Capt. G. L. Cheshire, Dr. J. Bronowski, Sir George Thomson, Capt. Cyril Falls, Prof. P. M. S. Blackett, Sir Henry Dale, Bertrand Russell, Sir John Anderson and Henry Wallace; with Commentaries by Students of Different Nationalities. Pp. x + 180. (London: Winchester Publications, Ltd., 1947.) 8*s*. 6*d*.

THE talks on "Atomic Energy: the Present and the Future" which the British Broadcasting Corporation arranged during March last year, first in the Home Service and afterwards in the 'third programme', have now been published in book form. To them have been added a series of comments by younger men and women representing American, Russian, German and Chinese points of view, and the talk on atomic energy which was given by Mr. H. A. Wallace in the third programme of the British Broadcasting Corporation during his recent visit to Great Britain. While these comments are of interest as indicating the attitude of the younger generation to the problems which atomic energy presents, and in particular reveal a general readiness to face the sacrifice of national sovereignty involved in any scheme of control, they add very little to the substance of the symposium. Moreover, the comments are not very clearly distinguished from the actual talks: the reader who missed the actual broadcasts is left to identify them chiefly by the biographical notes. The titles of the broadcasts have been discarded, and the substitutes are scarcely an improvement on the originals. An equally important blemish is the omission of any indication as to the dates when the broadcasts were given; those who wish to study the actual broadcasts may well be better served by *The Listener* of May 13, 1947, in which the series was first published.

Annual Review of Microbiology

Charles E. Clifton (Editor), Sidney Raffel (Associate Editor), and H. Albert Baker (Associate Editor). Vol. 1. Pp. vii+404. (Stanford, Calif.: Annual Reviews, Inc., 1947.) n.p.

IN the preface of this latest 'Annual Review' it is explained that a canvass of representative microbiologists indicated that their interests were not sufficiently covered by an already large number of periodical reviews covering at least many parts of the same subject. Time alone will show whether this opinion is justified. The term 'microbiology' may be taken to cover the whole physiology of organisms too small to observe without a microscope. It includes, therefore, morphology, biochemistry, genetics and all interactions with external environments of Protozoa, Bacteria, Fungi and so forth. Until recently, these subjects have been the concern of different groups determined by differences in technique, and undoubtedly this has led to a poor diffusion of knowledge of matters which are applicable to all groups. In some sections, however, this deplorable situation has been relieved by the publication of reviews in existing periodicals. Particularly this has been so in the chemical field, and it may now be doubted whether there is much ignorance of the biochemistry of one form of life among the students of another; at least in the particular field of biochemistry the student is interested in. It can scarcely become practicable for anyone to develop an abiding interest in many branches of a subject which has no biological limits. The present volume presents articles of widely diverse interest. The fractions of each subject covered are necessarily so small that the reader must still rely on the many reviews appearing elsewhere on practically the same field. Any of the articles could properly have appeared in existing reviews and, curiously enough, one of them has already done so. The articles which the reviewer is capable of judging are of a high order and presented with a personal touch which is valuable. Certainly an active worker must run his eye through this further addition to his survey of information, but he must not expect that this annual review alone is going to keep him abreast of developments. PAUL FILDES

A Text-Book of Practical Organic Chemistry

Including Qualitative Organic Analysis. By Dr. Arthur I. Vogel. Pp. xxiii+1012. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 42*s*. net.

DR. VOGEL'S books on analysis are widely used in teaching practical inorganic chemistry. His new volume is intended as a comprehensive laboratory manual for students of organic chemistry. It gives a full and valuable description of organic chemical technique, details of preparation of more than six hundred compounds, and a scheme of qualitative organic analysis. There are appropriate notes on the preparative reactions described and on the properties of the various classes of organic compounds. A curious omission is the almost complete absence of reference to quantitative organic analysis. It seems to the reviewer that some practice at least in quantitative elementary analysis is of value in the student's training, even in these days when the fully fledged organic chemist hands his analysis specimens to the microanalyst for determinations which he is usually quite unable to carry out himself.

It is a little doubtful whether such an elaborate laboratory text-book will attract the average undergraduate student, who would certainly not wish to work through all the preparations described. It will have a greater appeal to teachers and research workers, although the almost complete absence of references limits its usefulness to these. The book is well produced and well illustrated, and the only error which has been noticed is in the structure assigned to hexamethylene tetramine. J. W. COOK

The Right Way to Understand the Countryside

By Stanley A. Manning. (Right Way Books.) Pp. viii+116+4 plates. (London: Rolls House Publishing Co., Ltd., n.d.) 5*s*.

IN attempting to provide information about "trees, shrubs and woodlands, wild flowers and plants (including fungi, mosses, etc.), insects, animal life, birds, countryfolk, customs and folk lore", as well as "information on the National Forest Parks, Youth Hostels Association, local clubs, research areas, etc.", in 113 pages, Stanley Manning might well have considered if he might not have made his book a little longer. He might also have considered whether the use of technical terminology is advisable in a book meant for beginners and whether the introduction of controversial issues should not be left to a later place than the first chapter. This is particularly so since anyone who reads right through the book will realize that Manning has much of value to offer to the novitiate in country ways and customs. The scraperboard drawings by Elaine Hancock are attractively done, but perhaps not so suitable as line drawings for a book of this kind. T. H. HAWKINS

ORIENTATION OF BIRDS ON MIGRATORY AND HOMING FLIGHTS

A GENERAL discussion on the "Orientation of Birds on Migratory and Homing Flights" was held at a meeting of the Linnean Society of London on May 13, the president, Prof. G. R. de Beer, being in the chair. A full report will appear in due course in the *Proceedings of the Linnean Society* (160, Part 2; 1948).

The opening speaker, Dr. W. H. Thorpe, discussed the extent to which the facts of bird migration and homing could be accounted for on the basis of known senses and sense organs. There are two aspects of the problem: (*a*) the ability of a migrating or homing bird to take up the right direction of flight, and (*b*) the ability to maintain a given direction once started even though unfamiliar with the territory and in bad visibility. Observations and theories dealing with the second aspect were discussed in detail. It was concluded that while we need to know very much more than we do about the extent of night migration in overcast weather, theories of visual orientation already go a very long way towards accounting for the known facts, and no other type of theory appears inevitable at present.

The ability of birds to take a correct initial direction of flight perhaps provides more difficult problems. This raises the question of the existence of some innate sense of direction, and in this connexion the recent work of Ruppell[1] on the movements of hooded crows (*Corvus c. cornix*) displaced from their normal migration routes was described. It was argued that these results provide good evidence for the ability of young hooded crows to maintain an approximately correct general direction of migration independently of the company of experienced birds and knowledge of the landmarks. This work, however, does not require the assumption of any mysterious sense of direction since this species migrates by day and the general direction may well have been maintained by a combination of time sense and orientation by the sun.

The work of Griffin[2] on the homing and migration of birds was then discussed, and it was pointed out that provided we assume that the bird is familiar with a considerable area of country around its nest and is not, therefore, homing to a restricted point, random radial scatter and very approximate spiral exploration might account for a very large proportion of the published experiments on homing. In this connexion the importance of obtaining evidence as to the actual course followed by individual birds when released in unfamiliar territory was stressed and the work of Griffin on the herring gull (*Larus argentatus*)[3] and gannet (*Morus bassanus*)[4] was described. It was pointed out, however, that there are some observations on the direction-finding of homing and migrating birds which seem at present inexplicable on the basis of known senses and sense organs, and that a careful search for other possible methods of orientation was fully warranted. Orientation by kinæsthetic receptors seems ruled out, and it was assumed that there is no satisfactory evidence for infra-red vision among birds. Finally, the recent work of Yeagley on the homing and orientation of pigeons was described and critically discussed. Yeagley[5] now claims to have shown that trained homing pigeons can navigate by correlating visual estimation of instantaneous land speed with sensitivity to the vertical component of the earth's magnetic field and to a Coriolis force. These two influences together form a navigational gridwork of two sets of lines. By this means the bird is supposed to be able to fly to its home, which is a unique point in the gridwork, or to a related 'conjugate point' existing in the gridwork at a position other than its home. Yeagley's first experiment, the 'magnetic wing' experiment, which the author regards as securing "positive though limited data for the electromagnetic phase of the theory", was criticized in detail by Dr. Thorpe and found quite inadequate as a basis for such conclusions. The rest of the 'evidence' produced by Prof. Yeagley consists of a series of experiments in which a total of more than five hundred pigeons were used. The method adopted depends on the fact that for any point in the eastern coastal States of the United States having a particular magnetic-Coriolis characteristic there will be one other, and only one other, 'conjugate point' having the same characteristics at a corresponding latitude somewhere in the Dakota–Nebraska–Kansas region. Thus "if a bird locates its home by navigating to the intersection of the proper magnetic vertical and the proper latitude he should as readily navigate to the conjugate point as to his home if released nearer the former". Pigeons were trained at State College, Pa., to return to a conspicuous mobile loft from up to seventy miles in various directions. Loft and pigeons were then transported to Nebraska and the pigeons released mostly at distances between twenty-five and seventy-five miles from the conjugate point. On the theory, it would be expected that pigeons should be able to home to the new locations as easily as to the old.

It was pointed out that the method of presentation adopted by Prof. Yeagley in his paper, and particularly his method of total flight vectors, was highly misleading. Moreover, two thirds of the birds used were lost during the course of the experiment —the results described referring to the remaining third only. Yeagley does not subject his data to any statistical analysis, nor are enough details given to enable any satisfactory assessment to be made by others; but such statistical significance as the results appear to possess may be accounted for by observational bias. The experiments involved transporting and setting up large mobile lofts which were rendered as conspicuous as possible in order to increase the chance of the pigeons finding them, although far less than 1 per cent of the birds succeeded in doing so. Thus, for 'returns' the experimenters had to rely on the birds being found and records sent in by pigeon fanciers, farmers and others up and down the country. It seems only reasonable to assume that large-scale experiments of this kind with the lofts set up in the region where the birds are expected to return were likely to attract a good deal of local interest and attention. Unless great care had been taken to prevent any information about the experiments becoming public, or to ensure that the birds were looked for equally intensively in the areas where they were not expected to appear, the results are open to great suspicion. No mention is made in Prof. Yeagley's paper of any precautions having been taken in this connexion, and so it must be assumed that they were not, in fact, taken. It is also unfortunate that there were no control releases of Pennsylvania-trained birds farther from the conjugate point. Thus, after careful examination of Prof. Yeagley's paper

one is forced to conclude that no evidence has been produced that birds can navigate by a magnetic-Coriolis grid.

Dr. D. H. Wilkinson discussed recent theories of bird orientation which have invoked the use of Coriolis forces for determining latitude, and the vertical component of the earth's magnetic field for supplying the second co-ordinate. If a bird is to 'home' to within twenty-five miles at latitude 45° the effects by which it does this must be measured to an accuracy of about 0·5 per cent. The characteristics of home must, of course, also be remembered to the same accuracy.

The magnetic effect was discussed first. If the bird responds directly to a magnetic field, its problem is simply the measurement of it to 0·5 per cent. It is unlikely that birds have such a response, and it has been suggested by Yeagley that the potential difference induced by the linear translation of a conductor through the field may be detected. The first comment is that this potential difference would be unable to supply a current, and so the bird is called upon to make a purely electrostatic measurement of 10^{-5} volts per cm. of conductor to an accuracy of 0·5 per cent. These figures assume a bird flying at 40 m.p.h. at latitude 45°. The second comment is that there are present in the atmosphere potential gradients of the order of 1 volt per cm. These fluctuate widely and may change by several per cent in a mile. Even if there were no fluctuations the bird's problem would not be the measurement to 10^{-7} volts or so in 10^{-5} volts, but in 1 volt, an accuracy of 1 part in 10^7, not 1 part in 100. Such a measurement is impossible even leaving out of account the bird's necessity of knowing its air-speed accurately to 0·5 per cent. A second type of induction method which should be mentioned would consist in the rotation or oscillation, by the bird, of some conducting loop contained within its anatomy. Such a method gives a current of order $10^{-6}/R$ amp. for a loop of area 1 cm.^{2} and resistance R ohms oscillated with a period of 1 second. This method would remove the objection on the grounds of the earth's electrostatic field, the current due to this being of the order $10^6/R$ times smaller. Neither would the air-speed have to be known, though this would be replaced by a knowledge of the period of oscillation. The effect is again far too small to be considered, both in view of its absolute magnitude and of the existence of far larger natural currents in the bird's body. One therefore concludes that any measurement of the earth's magnetic field with the required precision is most highly improbable.

The Coriolis force is a sideways force experienced by a point which moves in a path the centre of curvature of which itself moves in a curve. It is then a purely geometrical effect, and has no explicit connexion with the rotation of the earth. It is only when the instantaneous rotation of the bird's flight is essentially that of the earth that the Coriolis force effects can be interpreted to yield the latitude. This means, in effect, that the bird must fly an extremely true course—and know that it is so flying. For the spurious Coriolis forces due to the inaccuracy of the bird's flight not to become comparable with those due to the rotation of the earth, the flight must have an instantaneous radius of curvature of about 100 miles or greater. This means a flight true to 1/50 in. in 100 ft., which is manifestly impossible. Though consideration of this fact alone is enough to show the impossibility of using Coriolis forces, the magnitudes are again far too tiny. As for the magnetic effects, there are two ways of using Coriolis forces, one crude and one refined. There is, indeed, close similarity in the analytical expression of the effects. The first suggestion to be considered is that of Yeagley, who supposed the bird to perceive the Coriolis force acting sideways on its body when in level flight. For our typical 40 m.p.h. bird this amounts to 1/6,000 g. As this force is no different in effect from the gravitational force, the only difference to the bird is that gravity now seems to act at a small angle to its true direction. The 0·5 per cent accuracy requirement means that this angle must be measured to about 0·2″ of arc. The bird has no idea where to measure this angle from, since gravity itself is not available, neither does gravity act at right angles to the earth's surface. In any event, if the bird's flight is not true to an extreme degree (the same order as remarked above) plain centrifugal force will exceed the Coriolis. The second suggestion came first in time, being that of Ising[6]. He considers the swirling motion of the fluid in an oscillating ring induced by Coriolis forces. Criticism has already been made[7] of the magnitude of the effects, which would be lost in the Brownian motion of the detecting organ. In any event, Ising's considerations are only of interest for a sitting bird because of the above remarks as to truth of flight. The conclusion, then, is that the Coriolis force is as useless as the magnetic field for bird orientation.

Finally, Dr. Wilkinson discussed the interpretation of homing experiments which seek to establish the existence of a double co-ordinate system. If a method such as Yeagley's 'total flight vector' be employed, the releases must not be symmetrical with respect to either of the co-ordinates or their normals through the point towards which flight is sought. If the homing then were only in one co-ordinate and the releases had such symmetry, the 'total flight vector' would point to the desired point, and no conclusion could be drawn as to the double co-ordinate homing.

The possibility that birds 'home' in one co-ordinate only should be seriously considered since the random search labour in which a bird is involved when it can home in, say, latitude only is enormously reduced. It may be that it is unnecessary to explain how birds 'home' to a point, but merely how they 'home' to a line. Such latitude homing may surely be accomplished with the aid of the sun-determination of its highest point to one diameter, giving latitude to thirty miles.

Prof. R. J. Wojtusiak, who had hoped to be present, had unfortunately to return unexpectedly to Poland. In his absence, Mr. H. W. Parker gave a brief summary of his paper entitled "Polish Investigations on Homing in Birds and their Orientation in Space"[8]. This paper summarizes the published work on the homing of wild birds, especially swallows and storks, hitherto carried out in Poland. Evidence was produced that visual recognition of landmarks plays a very important part in the homing orientation of swallows, and that once a homing flight from a particular locality has been accomplished, subsequent flights by the same bird over the same route will be performed at a much greater average speed. The possibility of infra-red vision as an aid to orientation was discussed and evidence brought forward[9] that the eyes of water tortoises are sensitive to infra-red. Similar experiments now in progress with pigeons were briefly mentioned, and it was claimed that positive results had already been obtained.

Dr. A. Landsborough Thomson pointed out that our ignorance of bird navigation is so great that we cannot afford to neglect any suggestions however far-fetched they may seem. He did not think that the suggestion that young birds migrating for the first time without their parents might merely have a tendency to go southwards towards the sun would carry us very far, since so much migration is not in the north-south line. He had no doubt at all that visual recognition plays a very large part in the orientation and migration of birds; but it does not, so far as we can see at present, give us a complete answer. Dr. Thomson agreed with previous criticisms of Yeagley's experiments, particularly because the birds were taken to the conjugate point and in some cases had been accustomed to that point before being taken to the release point. They should have been taken to the release point first.

Prof. V. C. Wynne-Edwards gave an account of his experiences with the release of herring gulls, and expressed agreement with the criticisms of Yeagley's work. He adhered to the view that in the end we shall find everything can be explained on a visual basis. He also suggested the possibility that the excellent time sense of birds might enable a bird to recognize a particular latitude by the time of sunrise.

Mr. James Fisher suggested that operating on a deliberate bias might be one of the methods by which birds can find their way in unknown country more efficiently than by theoretical spiral travelling. Thus if Lack and Lockley's famous shearwater released at Venice had operated on the principle of going along a right-handed coast it would eventually have reached the Bay of Biscay and thus presumably familiar territory.

Mr. B. W. Tucker agreed with the criticisms of Yeagley's experiments which had been put forward. But while much migration and homing can be explained in terms of visual responses, he felt that this cannot at present account for everything, and there are phenomena which are not completely explicable on the basis of any of the straightforward known senses. He pointed out that particular difficulties were raised by migration to oceanic islands and by the orientation behaviour of birds such as penguins.

Dr. M. H. Pirenne dealt with the subject of the sensitivity of birds' eyes and gave details of his experiments on owls and their response to infra-red rays. Discussing the work of Wojtusiak, Vanderplank and others, he pointed out various difficulties of interpretation and concluded that satisfactory evidence for infra-red vision is still lacking both in reptiles and birds. The fundamental difficulties raised by the infra-red radiation of the eye itself and associated tissues and by the infra-red absorptive power of the water in the eye were also discussed.

Mr. R. G. Newton suggested various possible methods by which the exact route taken by birds on release might be more easily traced.

[1] Ruppell, W., *J. Orn. Lpz.*, **92**, 106 (1944).
[2] Griffin, D. R., *Quart. Rev. Biol.*, **19**, 15 (1944).
[3] Griffin, D. R., *Bird Banding*, **14**, 7 (1943).
[4] Griffin, D. R., and Hock, R. J., *Science*, **107**, 347 (1948).
[5] Yeagley, H. L., *J. App. Physics*, **18**, 1035 (1947).
[6] Ising, G., *Ark. Mat. Astron. och Fysik*, **32** A, N.18.1 (1945).
[7] Thorpe, W. H., and Wilkinson, D. H., *Nature*, **159**, 903 (1946).
[8] Wojtusiak, R. J., *Proc. Linn. Soc.*, **160**, Part 2 (in the press, 1948).
[9] Wojtusiak, R. J., *Bull. Acad. Polon. Sci. et Lett. (Classe Sci. Math. et Nat.), Ser.* B, *Sci. Nat.*, **2**, 43 (1947).

MEDICAL RESEARCH DURING WAR-TIME

CRITICS of science, whatever their motives, have not neglected to make capital out of the destructive uses to which scientific results have been put by man; and critics of planned research, moved no doubt by purely scientific reasons, have vigorously asserted that planning hampers and may ruin the creative abilities of scientific men. To both these groups of critics the Report of the Medical Research Council for the years 1939–45, entitled "Medical Research in War" (Cmd. 7335. London: H.M. Stationery Office, 1947. Pp. 1–455. 7*s.* 6*d.* net), is to be commended. For in it the former will find a long record of beneficent uses to which scientific results have actually been put; and the latter will learn from it that planning, provided that it is wisely done by broadminded men who understand, and themselves experience, the mental processes and disciplines of scientific work, can produce both useful results and fundamental discoveries which advance the frontiers of knowledge. The proviso is a *sine qua non*; for planning that fails to recognize the basic individualism of scientific men and their kinship with artists imposes fatal limitations upon the research worker. The report is, for this reason, a tribute, not only to the men and women who have done the humane work that it records, but also to those who have, in their several ways, created and woven the themes treated, made the opportunities and provided the money and equipment without which the work could not have been accomplished.

The report, as its title implies, covers work done during the period of the Second World War. Military and industrial requirements, and also the health of the civil population therefore dominate its contents. The extent of the achievement recorded and the variety of the different, but often related, subjects investigated make it impossible, in a short review, to do much more than whet the appetite, so to speak, of potential readers and to invite them to read the report itself.

Apart from the information given about the composition and functions of the Medical Research Council and its committees, its arrangements for liaison with other men of science and scientific organisations in the United Kingdom, in other parts of the Commonwealth and in Allied countries, the names of its personnel, the publications of its research workers and the Council's own reports and a good deal of kindred information, there are fifteen sections which describe specific researches in considerable detail. These are summarized in a valuable "Introduction".

The subsequent sections deal with work on wounds and injuries; war diseases; therapeutics, including a useful account of the work on penicillin; war-time nutrition; personnel research done to increase the efficiency of the Fighting Services; health research in industry; special emergency services, such as blood transfusion, the emergency public health laboratory service in Britain and the supply of necessary immunological sera and antitoxins; the preparation and maintenance of biological standards of such substances as penicillin, vitamins A and E, heparin and certain serological reagents, together with the maintenance of the national collection of type cultures of micro-organisms; and a great deal of other work done either at the National Institute

for Medical Research or elsewhere on a variety of subjects, of which the control of cross-infection in hospitals, the birth-rate, population trends, air-borne infection, the remarkable work on scrub-typhus and research on burns and scalds and applied psychology are a few examples. The report, in fact, amounts to a guide to the major trends of medical research in Britain at the present day.

The three main objectives of all this work have been: (1) the maintenance of the health of the Armed Forces and the civilian population, with special regard for malnutrition and the prevention of infectious diseases; (2) the restoration of the wounded and sick to full health; and (3) the creation of conditions which will ensure the highest possible efficiency, safety and comfort of fighting personnel and industrial workers in time of war.

The effort to attain the first of these objectives was very successful. Epidemic infective disease has always been a military menace, but during the Second World War it was reduced to military insignificance. In civil life it was also checked, although the common cold, influenza and a variety of industrial hazards remain and are recognized as urgent problems which are now being energetically investigated. The value of the nutritional work done during the War is so well recognized that it needs no comment here.

The success of the attack on the second objective is probably not fully appreciated outside the medical profession. Powerfully aided by the discovery of the sulphonamide drugs and the effects of penicillin, and by remarkable advances in surgical treatment, the work done in this field saved the lives and returned to useful occupation many men and women who formerly would have either died or would have survived only in helplessness and misery.

The story of the attack on the third objective is in some respects the most interesting part of the report. It includes accounts of the work on the physiology of flight at high altitudes and of deep-sea diving; the design of clothing for airmen and for life in arctic and tropical climates; the human problems associated with submarines and surface ships; the design of aircraft, guns and armoured vehicles in relation to the abilities and needs of the men who use them; and the special problems, physiological and psychological, arising from the use of complicated panels of instruments, engine controls and similar devices inseparable from modern mechanized warfare and industry.

As the report says, the main factor limiting the efficiency of a machine or weapon may be the human being using it, so that machines and weapons should not be designed by physicists and engineers without the co-operation of the psychologist, the physiologist and the medical man. To industry the same considerations apply. Lighting, heating, ventilation, noise, dust, toxic products of the factory—all these, as well as the relations between the machine and the people who use them, need scientific study if the best economic, social and humane results are to be attained.

During the period covered by the report the Medical Research Council has unhappily lost by death or retirement the services of men whose experience and creative ability were very valuable. The deaths of Sir Patrick Laidlaw and Sir Thomas Lewis, to whose influence and achievement the report pays tributes, were grievous blows. Although Sir Henry Dale retired after twenty-eight years of active service, he remained on the Council for four years longer, and his wide experience and outstanding ability are still happily available in consultation. Sir Edward Mellanby, secretary of the Medical Research Council, is fortunately still in office. He must be well satisfied with this record of the work to which he has devoted so much wise counsel and prolonged hard work.

G. LAPAGE

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, AUSTRALIA

ANNUAL REPORT

THE twentieth annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia, covering the year ended June 30, 1946 (Canberra: Gov. Printer. 5*s.* 4*d.*), now available, refers to the decision to establish a Division of Textile Research as a result of the visits of Mr. B. H. Wilsdon, Prof. J. B. Speakman, Dr. F. T. Peirce and Dr. A. C. Goodings mentioned in an earlier report; negotiations are in hand for the acquisition of a site for the headquarters laboratory at Geelong. Some work in the wool textile field will be undertaken by existing divisions.

The Building Materials Research Section and the Flax Research Laboratory came into existence during the year, and experimental work in nuclear physics and metallurgy was initiated in collaboration with the University of Melbourne. The Council has resumed its earlier practice of sending members of its scientific staff overseas to collect information on new developments and to acquire general experience in research and training in new techniques. A series of studentships is also to be offered each year to enable recent graduates of Australian universities to gain general research experience and training overseas in subjects related to the Council's programme of research, and then to return to Australia as members of the Council's staff. The Council's scientific liaison offices in London and Washington are now being maintained on a restricted basis to serve the peace-time needs of the Council.

With the end of the War, the Division of Plant Industry is devoting much more time to a study of pasture and weed problems, and the joint State and Council Weeds Co-ordination Committees are being revived. The North Australian Development Committee established by the Commonwealth Government and those of Queensland and Western Australia initiated a rapid examination, in the Katherine–Darwin–coast area, of the vegetation in relation to geology, soils and climate, the distribution, grazing and quality of stock, etc., during the 1946 dry season. Another committee on which the Council is represented, with the Waite Agricultural Research Institute and the Departments of Agriculture of South Australia and Tasmania, has been established to supervise investigations of dieback or 'gummosis' of apricots. Pasture investigations have included the management of *Phalaris* – subterranean clover and of Wimmera rye grass – subterranean clover in sown pastures, and a large-scale grazing trial of natural pasture in co-operation with the New South Wales Department of Agriculture. Mineral deficiency, pasture establishment under cover crops, various studies of mixtures of lucerne and *Paspalum sero-*

biculatum, and studies of cattle pasture and native legumes are also reported. Weed investigations have ranged over the control of galvanized burr, mint-weed, capeweed in flax crops and studies of the action of plant poisons. Facilities for plant testing were re-organised and developed, some 510 species and varieties being received from abroad for trial during the year, while more than a thousand samples of seeds of Australian native and crop plants were sent to overseas agricultural and botanical institutions. Trials of introduced linseed varieties gave particularly promising yields, and linseed is believed to have good prospects as a commercial crop in southern Queensland. Experiments with the guayule rubber plant continued, and plants grown at Lawes under natural rainfall compared favourably in yield and rubber content with the best irrigated plantings in South Australia. Wheat investigations covered take-all disease. The study of fruit storage problems was again taken up, and work on the vitamin C content of tomato varieties continued. Trials with dichloroethylene and dichloroethane gave good results in the control of woolly aphis in propagating beds, and aspects of the dieback disease of apricot have been surveyed. Drug plant investigations have been concentrated on the study of *Duboisia* spp. as sources of hyoscine and atropine; the study of varieties of *Papaver somniferum* as sources of opium alkaloids; and the systematic search for sources of pharmacological and insecticidal substances in native plants. Vegetable investigations have included genetical work aimed at producing hybrids resistant to the potato viruses A, X, Y and leaf roll; agronomic studies of selected varieties of tomatoes; peas and beans; the use of zinc oxide as a disinfectant on cut potato setts; and spotted wilt of tomato.

Reports from the Divisions of Economic Entomology and of Animal Health and Production both give some prominence to trials with D.D.T. and 'Gammexane'. A preparation of the former, known as 'Rucide' and containing 50 per cent of the *pp*-isomer, which forms a stable fine emulsion when melted and poured into water, has given very promising results against cattle tick, in control of buffalo fly on dairy cattle and beef cattle, oriental peach moth, potato moth and cabbage moth and butterfly. D.D.T. has also given promising results in control of sheep blowfly. Other work by the Division of Economic Entomology has been concerned with the biological and clinical determination of D.D.T. and other insecticides, the biological control of cabbage white butterfly, citrus red scale, brown olive scale and potato moth, the insect control of St. John's wort, and insect vectors of plant viruses. The Division's work on wheat-storage problems terminated during the year; but promising results were obtained both with D.D.T. and '666' against hoppers and adults of the Australian plague locust. In the Division of Animal Health and Production, systematic epidemiological studies of mastitis were continued on the experimental herds of dairy cattle, and the good results obtained with penicillin in bacterial infections of the udder have been confirmed. Other investigations have covered toxæmic jaundice in sheep, contagious abortion of cattle and the toxicity of wheat for stock, while at the McMaster Animal Laboratory studies have been made of anthelmintics against *Hæmonchus contortus*, *Trichostrongylus* spp. and *Œsophagostomum columbianum* as well as of the administration of phenothiazine in salt lick and in small repeated doses, the effect of worm parasites on body weight and wool growth, external parasites of sheep and the blowfly strike problem. Biochemical studies have included the mineral metabolism of sheep and poisonous plants; studies in wool biology have included specifications of sheep types for wool production and histological studies of the sheep's skin. At the F. D. McMaster Field Station, studies have been made of the inheritance of skin wrinkles in sheep and of various faults and specific breeding groups. An investigation has been commenced into beef production in Australia, and an officer has been appointed for poultry breeding investigations.

The study of the nutritional physiology of ruminants has again been undertaken, particularly with the view of extending knowledge of the chemical, microbiological and physiological mechanisms involved in rumination and in the production of wool fleece, and the detailed study of the influence of protein intake on the latter has already indicated several broad principles. Other studies in the biochemical field have covered chronic fluorosis, the influence of deficiencies of minor elements, cobalt and copper deficiency and the effect of copper and cobalt dressings on grazing sheep. Soils investigations have been concerned mainly with problems in land settlement; surveys of various types have proceeded in five States. Considerable attention has been given to the place of soil investigations in research on building problems with particular reference to foundations, but lack of qualified research staff has hampered development. Irrigation settlement investigations at Merbein, Victoria, and Griffith, New South Wales, have proceeded on the usual lines, covering irrigation and drainage problems, soil moisture problems of irrigated lands, soil deterioration from irrigation, viticulture, fruit processing and vegetable agronomy.

In the field of forest products there has been a rapid transition from war-time problems to research on peace-time problems, and heavy demands from industry for assistance, particularly in connexion with housing, have been received when the Division concerned was short of staff through transfers. A feature of the year was the first Forest Products Conference, to which representatives from all the State forest services and from the Commonwealth Forestry and Timber Bureau and the Forest Department of the New Guinea and Papua Administration were invited. A major purpose of the Conference was to discuss programmes of work of the Division, the Division of Wood Technology of the New South Wales Forestry Commission and the Queensland Sub-Department of Forestry. Co-operation with the pulp and paper industry in the field of wood chemistry continued, and further work was carried out on lignin and pulp evaluation. The Timber Physics Section continued its work on wood–water relations and the physical properties of wood, while the Timber Mechanics Section, in addition to testing work, also made fundamental studies of the properties of wood, long-time loading and the strength and deflexion of floors. Work was also carried out in the Division on the development of building materials from wood products and other organic substances and on timber preservation, marine borer attack, fundamental factors affecting the penetration of preservatives under pressure, the diffusion of soluble preservatives into green timber, veneer and glueing, and the development and testing of adhesives.

Important changes have been made in food preservation investigations. All short-term investi-

gations to maintain or increase the output of canned foods have been terminated to permit concentration on such long-term projects as the effects of maturity and variety on the quality of certain processed fruits and vegetables. Investigations on the storage of egg powder have been terminated, and work on the processing and storage of dehydrated vegetables curtailed; while studies on preventive measures for bacterial rotting in shell eggs have been resumed, as have some fundamental studies on the metabolism of fruit in cold storage and on problems of heat transfer and evaporation in cooling meat in refrigeration chambers. Other investigations have dealt with the organisation of the plant cell and its relation to cell stability and the respiration of the plant cell, particularly the organic acid metabolism and the nature of the oxidative enzymes, skin coatings for apples, the effectiveness of 'Pliofilm' wraps, 'stretch wraps' and case liners compared with a standard wax treatment for storing oranges. Features of the year's work on canning and fruit products were modified procedures for canned citrus juices, the canning of Freestone peaches, the steam-flow, hot-lid method of obtaining vacuum in commercial automatic can-closing machines and the maintenance of colour by addition of soluble tin to fruit packed in lacquered cans.

The exceptionally interesting report from the Fisheries Division refers to the return of the Division's research vessel from the Royal Australian Navy and the gradual resumption of research activities. The routine testing of the new southern trawling grounds with the Danish-seine net continued, and biological investigations covered Clupeoid fish, whitebait and *Tuna* species, salmon and mullet. Hydrological and seaweed investigations are also recorded, including both the production of agar and the use of seaweed as fodder; many aerial observations of pelagic fish were made from aircraft allotted by the Royal Australian Air Force.

The work of the Division of Electrotechnology has been devoted almost entirely to the establishment of the facilities required for the maintenance of standards and for measurements, and release of the staff of the Physics Division from routine testing has permitted further attention to research. Fundamental investigations on the physics of wool fibres, particularly in relation to their frictional properties, have been continued and extended to include studies of the ultimate structure of the fibres. Further work has been done with the view of maintaining the International Temperature Scale quite independent of secondary standards calibrated elsewhere, and an instrument has been developed for measuring the temperatures of estuarine muds and waters. Some work on solar physics has been commenced, and the nucleus of a section to work on the physics of solids has been established.

The Division of Aeronautics is now concentrating on more fundamental and long-range problems, turbine engine research being particularly prominent. The instability characteristics of flat and curved plates of both isotropic and orthotropic material have been investigated, and work on plywood plates subjected to end compression has been carried further. Preliminary work has been undertaken on tungsten-chromium alloys, and tests on the corrosion of the alloys of mock-up cooling systems by inhibited and uninhibited ethylene glycol has been continued with a coolant containing sulphonated gyro-oil as inhibitor. A study has been made of the mechanism of corrosion and film formation in aluminium and its alloys. In the Division of Industrial Chemistry the process devised for the preparation of chrome chemicals from chromite by an acid treatment reached an advanced stage in pilot plant, and pilot plant tests have also been undertaken on the chemical isolation of cerium, thorium and lanthanum compounds from monazite. A survey is being made of Australian ceramic materials, and the Physical Chemistry Section has continued its work on surface chemistry with particular reference to aspects affecting the flotation process for the separation of minerals. Corrosion in aircraft engine cooling systems and condenser tubes in power generating plant, the adsorption of surface-active agents from organic solvents, sugar-cane wax, the pilot-scale isolation of mannitol from the exudate of sugarwood, catalytic oxidation of ethylene to ethylene oxide and catalytic dehydration of 2 : 3-butylene glycol to butadiene, the loosening of wool from skins by sweating and with depilatories are among other problems which received attention during the year.

In returning to the study of fundamental problems, the Division of Radiophysics has placed emphasis on researches into the propagation of radio waves, atmospheric physics and vacuum physics. The Lubricants and Bearings Section, renamed the Tribophysics Section, has been concerned with the mechanism of boundary lubrication, surface damage and wear, silicones, surface-active compounds and mechanical properties, the deformation of metals by heating and cooling, deformation and recrystallization of duplex alloys and the electrolytic polishing of metals.

OBITUARIES

Sir George Newman, G.B.E., K.C.B.

GEORGE NEWMAN was born at Leominster, Herefordshire, on October 23, 1870. He was the second son of Mary Anna Pumphrey and Henry Stanley Newman, who for twenty years edited the Quaker weekly, the *Friend*. Sir George was educated at Bootham School, York, and the University of Edinburgh. He graduated M.B., C.M. in 1892 and proceeded to the M.D. in 1895, his thesis on leprosy qualifying for the gold medal. In the same year he obtained the Cambridge D.P.H. During 1896–1900 he was senior demonstrator in bacteriology and lecturer in infectious diseases at King's College, London, of which he was later to become a fellow. During 1900–7 he was medical officer of health of the County of Bedfordshire and of the Metropolitan Borough of Finsbury; and lectured on public health at St. Bartholomew's Hospital. He early acquired reputation as an energetic administrator, and published works on the bacteriology of milk, on the relation of bacteriology to public health and on infant mortality.

In 1907, Newman was appointed the first 'chief medical officer' of the Board of Education. With Sir Robert Morant, the permanent secretary, and his able colleagues, Dr. Eichholz, Dr. Ralph Crowley and Dame Janet Campbell, Newman built up the school medical service and extended its scope and opportunities. As a result, the mental and physical education of the children of Britain has improved beyond all comparison with the past. The years

from 1900 to 1919 were years of strenuous endeavour, and were perhaps the most constructive periods of Sir George's life-work.

The First World War gave a new impetus to preventive medicine, and in 1919 Dr. Addison, president of the Local Government Board, appointed Sir George Newman medical officer of the Board. However, the Ministry of Health was established in June of that year and took over the functions of the Local Government Board, the National Health Insurance Commission and other health activities; Sir Robert Morant became its secretary and Sir George Newman its chief medical officer, retaining his position under the Board of Education.

Newman's main task at the Ministry was to consolidate and develop the health services which had been established by the Local Government Board. Having to deal with wide issues, he was content to exercise general direction of the whole service. He therefore allowed his senior medical officers full scope in their respective spheres of work, although he was always ready to discuss important questions and decisions with them. In addition to his heavy responsibilities as chief medical officer of two departments, Sir George Newman undertook much other work. During the War of 1914–18 he was chairman of the Health of Munition Workers' Committee, which survives as the Industrial Health Board; he promoted the cause of temperance as medical member of the Central Control Board (Liquor Traffic); and served on many departmental and other committees. He rendered great service to medical education, not only in his special reports—"Outline of the Practice of Preventive Medicine" (1919) and "Recent Advances in Medical Education" (1923)—but also as medical assessor to the University Grants Committee, as Crown nominee on the General Medical Council during 1919–39, and in his work for the British Postgraduate Medical School and the London School of Hygiene and Tropical Medicine.

Newman was an indefatigable worker, a fluent speaker, an expert diplomatist, a philanthropist, and a lover of books and medical history. In his writings and in his long series of annual reports of his department, adorned with pregnant phrases and quotations, he maintained the literary traditions of his predecessors, Simon and Buchanan. These reports exercised great influence upon the general public, impressing upon them the importance and value of public health. At various times he delivered the Yale, Linacre, Gresham, Halley Stewart and Heath Clark Lectures and the Harveian Oration. He retired in 1935.

Sir George received many honours. He was knighted in 1911, created K.C.B. in 1918 and G.B.E. in 1935. His honorary degrees included D.Sc.(Oxon.), D.C.L.(Dunelm) and the LL.D. of London, Edinburgh, McGill, Toronto, Glasgow and Leeds. He was also F.R.C.P.(Lond.) (1918), Hon. F.R.C.S.(Eng.) (1928), and honorary freeman of the Society of Apothecaries. He received the Bisset Hawkins Medal of the Royal College of Physicians in 1935 and the Fothergill Gold Medal of the Medical Society of London.

Short of stature, with abundant white hair and white moustache, Newman was a well-known figure in Whitehall. His conversation was vivacious and dramatic. He married Adelaide Constance Thorp in 1898, and with her lived a happy and secluded home life. Lady Newman died in 1946. Sir George died on May 26, 1948, at York, at the age of seventy-seven, after a long illness.

ARTHUR S. MACNALTY

Dr. George H. Pethybridge, O.B.E.

GEORGE HERBERT PETHYBRIDGE, for many years one of the leading personalities in plant pathology in Great Britain, died in his native town of Bodmin on May 23 at the age of seventy-six. Born in 1871, of a family well known in legal, medical and banking circles throughout Cornwall, he passed from Dunheved College, Launceston, to the University College of Wales, Aberystwyth. He took an honours degree in science in the University of London, and, after a short period as science master at Kingswood School, Bath, and elsewhere, proceeded to the University of Göttingen in 1897. Here he studied under Prof. Berthold and obtained his doctorate for a dissertation on the effect of inorganic salts on the development and structure of plants.

Returning to Britain, he joined the staff of the Science and Art Department in the Royal College of Science, Dublin. When, in 1900, this body was taken over by the newly created Department of Agriculture and Technical Instruction for Ireland, Pethybridge became the first head of the Seeds and Plant Diseases Division of the Department. During the next twenty-three years he carried out a long series of researches on diseases of potato, flax and other crop plants. It was mainly his work on potato diseases that gained him world-wide recognition, including the award in 1921 of the Boyle Medal of the Royal Dublin Society. One of his innovations was to establish field laboratories in areas where the diseases were most prevalent.

By his thoroughness, enthusiasm and rigorous experimental methods he greatly stimulated the study of plant diseases in Ireland and set a very high standard for those who followed him. He was, moreover, a keen field naturalist, and in 1905 collaborated with R. Ll. Praeger in an account of the vegetation of the district lying south of Dublin, while in 1910, with J. Adams, he published a "Census Catalogue of Irish Fungi".

On the change of government in Ireland, Pethybridge resigned his post, and shortly afterwards in 1923 he became mycologist to the Ministry of Agriculture and Fisheries and assistant director of the Ministry's Plant Pathology Laboratory at Harpenden. From then onwards his work was of an administrative rather than a research nature; but he played a large part in promoting research in plant diseases—notably into virus diseases of plants—and under his guidance intelligence work on plant diseases occurring in England and Wales was second to none. His long and valuable services were recognized by the award of the O.B.E. shortly after he retired in October 1936.

Pethybridge clung tenaciously to his ideals, perhaps even at times in the face of progress, but to the many who came under his influence he was a most generous, helpful and homely friend, a delightful correspondent and a wise counsellor, at work as well as by his fireside. His scientific writings bear the stamp of careful preparation and of the thoroughness that characterized his whole life: he gave and demanded the best and despised the shoddy. Shy and retiring by nature, he usually avoided public life and office, though he was persuaded to accept the presidency of the British Mycological Society in 1926. Among other activities he served the *Journal of Pomology* in an editorial capacity from 1936 until 1948, and it is a fitting and timely tribute that the current volume is dedicated to him.

W. C. MOORE

Dr. A. S. Corbet

ALEXANDER STEVEN CORBET was born on August 8, 1896; on May 16, 1948, he collapsed from heart failure after hurrying for a train, and died shortly after. He was educated at Bournemouth and University College, Reading, taking honours in chemistry. Afterwards he took the Ph.D. degree, and in 1935 his D.Sc. in biochemistry. He joined the staff of the British Museum (Natural History) in May 1939, after an already varied career which had included appointments as bacteriologist at the School of Agriculture, Cambridge, bacteriologist and entomologist to the Rubber Research Institute, Kuala Lumpur, F.M.S., soil microbiologist at the I.C.I. Experiment Station, Bracknell, and bacteriological work with the Water Pollution Research Board.

Wide experience, linked with a life-long interest in entomology, resulted, when Corbet was enabled to devote his whole energies to the study of the butterflies of the world, in an approach and a method of treatment such as had not before been applied to these popular insects. A particularly successful example of his work was his treatment of the common and very variable sulphur-yellow butterflies of the genus *Eurema*, which had been a happy hunting ground of the name-coining 'splitters' of earlier days. Another was his revision of the rather intractable species of the 'Blues' of the Oriental genus *Arhopala*. In his work on the latter genus he made use of the parallel variation of a number of species occurring side by side throughout the Malaysian sub-region in a taxonomically novel way; he succeeded in defining the island races of particular species by reference to the general characteristics of each island group, thus eliminating a great deal of rather repetitive descriptive matter. The same parallelism among island species also emerged clearly from his revision of the species of the genus *Euploea*, a large group of butterflies which also had until then resisted many attempts by more orthodox methods to reduce them to order. In a few years he had, in fact, overcome most of the systematic difficulties which had hitherto dogged the attempts of less gifted students of the systematics of the oriental Rhopalocera. His results are contained in the new edition of his "Butterflies of Malaya", which he has left ready for the press. The collections he formed in Malaya are bequeathed to the nation.

During part of the First World War Corbet served with the Royal Engineers; in the Second World War he was seconded to the Pest Infestation Branch of the Ministry of Food, where he was able, among other things, to carry out research on the taxonomics of insect pests of food which has proved of direct economic value.

Corbet was a prolific writer who had the rare merit of not wasting words. Though his entomological work cannot now be rounded off, the results of his soil research in Malaya have already appeared in highly condensed form in a single slim volume, his "Biological Processes in Tropical Soils". As a colleague he was invaluable, his unassuming modesty cloaking a width of experience and interest, and a personality of great charm. N. D. RILEY

WE regret to announce the following deaths:

Prof. Alfred C. Lane, emeritus professor of geology at Tufts College, Massachusetts, president in 1931 of the Geological Society of America, on April 15, aged eighty-five.

Sir D'Arcy Thompson, C.B., professor of natural history in the University of St. Andrews, on June 21, aged eighty-eight.

NEWS and VIEWS

Geology at Newcastle-upon-Tyne: Prof. H. G. A. Hickling, F.R.S.

PROF. H. G. A. HICKLING is to retire at the end of this session from the chair of geology at King's College, Newcastle-upon-Tyne, which he has held since 1920. During this period he has greatly extended his own work in some of the branches of geology to which he had earlier made contributions, and his students have shown that wide range of interest which is characteristic of him. Already as a lecturer at Manchester he had investigated the Old Red Sandstones of east Scotland, described the footprints of fossil reptiles, examined the variations of gastropods, studied the structure of fossil plants, the microstructure of coals and the stratigraphy of the Lancashire coalfield; the latter topics he made his own at a time when coalfield work was thought by some to be scarcely suitable for academic geologists. At Newcastle he has added much to our knowledge of coals, and especially (by his development of techniques of section cutting) to the understanding of 'vitrain'. He has fittingly combined an active interest in the economic problems of the north of England with a full appreciation of the necessity for less obviously useful studies: all this has been to the advantage of his students. His work was recognized by the award of the Murchison Medal by the Geological Society in 1934 and by his election to the Royal Society in 1936.

Dr. T. S. Westoll

DR. T. S. WESTOLL, who is succeeding Prof. Hickling in the chair of geology in King's College, Newcastle-upon-Tyne, has had a distinguished career in geology and vertebrate palæontology. Graduating in 1932 in the College to which he now returns, he commenced research on the famous fish fauna of the Permian rocks of that area. He was awarded a Ph.D. and a senior research award of the Department of Scientific and Industrial Research, with which he proceeded to University College, London, to work with Prof. D. M. S. Watson. During his three years in that position, he visited many of the principal museums in Europe and commenced the work to which he has since contributed most widely, namely, the further study of the Old Red Sandstone and its faunas, particularly in the north of Scotland. In 1937, with grants from the Geological and Royal Societies, he spent several months in the United States and Canada, visiting the principal universities and museums, and commencing stratigraphical and palæontological field-work in the Gaspé Peninsula, New Brunswick and Nova Scotia. The latter important work was interrupted by his election to a senior lectureship at Aberdeen, though not before

it had led to important results both in the stratigraphy and palæontology of the Devonian and Carboniferous rocks of that region. In Aberdeen, field-work on the Old Red Sandstone of various areas of north-east Scotland, the Orkneys and Shetlands and on their faunas has been actively continued, along with investigations of the morphology and relationships of the various groups of fishes and the origin of tetrapod structures. This work has become of international repute. In 1941 the University of Aberdeen conferred on him the degree of D.Sc. In the following year Dr. Westoll was elected a fellow of the Royal Society of Edinburgh and a member of the New York Academy of Sciences. In 1947 he was invited to the Princeton Bicentenary Celebrations to participate in the conference on palæontology, genetics and evolution, and afterwards to the Paris conference on palæontology.

Chemistry at University College, Swansea: Prof. J. E. Coates, O.B.E.

THE pending retirement of Prof. J. E. Coates from the chair of chemistry marks the close of an important period in the history of the University College of Swansea, for, of the professors of scientific subjects appointed at the time of its foundation, he is the last remaining in the service of the College. After a brilliant career as student at Bangor, in London and at Karlsruhe, and distinguished service during the First World War in the Royal Naval Air Service, he was in 1920, when a member of the staff of the University of Birmingham, called to the professorship of chemistry at the newly established Swansea College of the University of Wales. It then fell to his lot to start, build up and maintain one of the major departments of the College, and the magnitude of his success in this arduous and responsible labour is demonstrated by the rapid advancement of the Chemistry Department to its present prosperous condition, and great service to the important industrial area in which it is situated. Under his direction, a foremost feature has been activity in research in physical chemistry, in which branch he was trained during his early investigations under the great masters, Ramsay and Haber. Among his studies while at Swansea have been the physical and chemical properties of hydrogen cyanide and its solutions. His past and present students, his colleagues and his numerous friends will all wish Prof. Coates many years of further fruitful activity.

Dr. C. W. Shoppee

DR. C. W. SHOPPEE has been appointed to the chair of chemistry in the University of Wales, tenable at University College, Swansea, in succession to Prof. J. E. Coates. Dr. Shoppee's earliest research work was carried out in 1923 at the Imperial College with Dr. C. K. Ingold and the late Sir Jocelyn Thorpe. In 1924, he accompanied Prof. Ingold to the University of Leeds, and in 1928, after having held an 1851 Senior Studentship, was appointed to the staff of that University. In 1939, he was elected to a Rockefeller Research Fellowship, which he chose to hold in the laboratory of Prof. T. Reichstein at the University of Basle. In 1944, he was appointed to a readership in chemistry in the University of London, tenable at the Royal Cancer Hospital (Free). Dr. Shoppee is distinguished for his researches on the mechanism and kinetics of tautomeric change, and for his work on the hormones of the adrenal cortex, which led to the establishment of the detailed structures of these physiologically important compounds. At the Chester Beatty Research Institute of the Royal Cancer Hospital (Free), he has applied his special knowledge of the microchemical and chromatographic investigation of natural products to the isolation and identification of the endogenous carcinogenic substances present in human tissues. In the steroid field, he has gained an international reputation, and his most recent work involves application of the new conceptions of the mechanism of organic reactions to the determination of chemical configuration in natural products, an ultimate aim being to illuminate the highly specific relationship between chemical configuration and physiological activity.

Engineering at University College, Swansea: Mr. L. J. Kastner

MR. L. J. KASTNER, of the Department of Engineering, University of Manchester, has been elected to the chair of mechanical engineering at University College of Swansea, which became vacant by the appointment in 1946 of Prof. R. N. Arnold to the regius professorship of engineering in the University of Edinburgh. Mr. Kastner took the Mechanical Sciences Tripos at Cambridge in 1934. Following a period of practical workshop training with Messrs. Davis and Metcalfe, of Romiley, he went to the University of Manchester to do research on internal combustion engineering, which led to the degree of M.Sc. In 1938, he was appointed to the staff of the Engineering Department at Manchester, and in 1945 became senior lecturer in the Department. While there he has been responsible for the advanced teaching in thermodynamics at Manchester and has also taken a large part in running the Engineering Laboratories. He has been actively engaged in research, more especially in the field of internal combustion engineering, and has published several original papers dealing with various aspects of this work. It is of interest to note that Mr. Kastner is now the third in the family line of university professors, his grandfather and father having in turn held the chair of French in the University of Manchester.

Department of Scientific Research, India

THE Government of India has created a Department of Scientific Research with effect from June 1. The Department will be in the charge of the Prime Minister of India, and Sir Shanti Bhatnagar, director of scientific and industrial research, has been appointed secretary and principal executive officer. The Department will take over the work of the Board of Research on Atomic Energy and the Council of Scientific and Industrial Research. The latter body, although attached to the new Department, will retain its unofficial character and will continue to function as before. The new Department will deal also with scientific advice to Government departments, *ad hoc* scientific research in universities and research institutions, research scholarships in applied scientific subjects, international scientific unions, scientific liaison offices, the Scientific Consultative Committee and such other subjects as may be transferred to it. The Department will co-ordinate the scientific activities of the other Ministries, and in this work it will be assisted by a co-ordination committee consisting of eminent men of science.

Engineers and the Community

In an address delivered at the annual luncheon on June 8 of the Institution of Gas Engineers, the president, Dr. Harold Hartley, made some interesting comments on the relation of the engineer to the community. The term 'engineering', he suggested, should be extended to cover all endeavour utilizing the processes of Nature or scientific knowledge for the benefit and pleasure of mankind. This wider concept of the functions of engineers would bring the professional bodies closer together and give them increased influence in public affairs. The professional institutions set the standard for their members, and they can use their influence to ensure that, in the struggle for economic development, the fundamental cultural freedoms are not sacrificed. They can see that conditions are created which will enable everyone to give of his best in his own particular field; they should strive after something of the character of the old craft guilds, with their care for the reputation of their craft and their members, but also with a deep sense of public service. Dr. Hartley's audience consisted largely of gas engineers, and he rightly emphasized his points by reference to their special branch of the profession of engineering. He referred to the spirit of tolerance and loyalty which has characterized the gas industry in the past, and expressed the belief that this state of mind would enable the industry to overcome the difficulties inherent in the fundamental re-organisation which nationalization of the gas industry in Britain will involve. The Institution of Gas Engineers as a corporate body represents a limited number of types of men with specialist knowledge who are accustomed to thinking along similar lines; they should not find it difficult to co-operate with other specialists concerned in different ways with the industry, and with them to solve the problems lying ahead.

Acta Crystallographica

Acta Crystallographica is a new journal of crystallography published for the newly formed International Union of Crystallography by the Cambridge University Press. It is intended to replace the former *Zeitschrift für Kristallographie*, which between the two World Wars had attracted most of the original accounts of crystal structure analyses. In scope, however, it is intended to be wider, and sets out to reassemble the crystallographic work now scattered through a great variety of journals, and to be the main journal for experts in crystallography the world over. Six numbers are to be issued annually at a moderate cost made possible through subsidies from Unesco, and from numerous research associations and industrial firms in Britain and the United States. The first number, published in March, contains six full-length papers and three short communications on structure determinations of organic and inorganic substances; together with notes and book reviews. The papers are clearly illustrated, and data and methods are set out in sufficient detail for assessing their reliability. Linked with this new publication will be periodic structure reports analogous to the seven volumes of "Strukturbericht" (1931–39) and also a second revised edition of the "International Tables for the Determination of Crystal Structure" (1935). The editor and co-editors are to be congratulated on so promising a first number of a new scientific journal which is really necessary.

World Power Conference

A two-day meeting of the International Executive Council of the World Power Conference has been held at Stockholm. Nineteen countries were represented: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Great Britain, Hungary, India, Italy, Netherlands, New Zealand, Norway, Poland, Sweden, Switzerland, Turkey and the United States. The British delegates were Sir Harold Hartley, chairman of the International Executive Council and of the British National Committee of the World Power Conference, who presided; Mr. Harold Hobson, vice-chairman of the British National Committee and lately chairman of the Central Electricity Board; and Dr. A. Parker, director of fuel research, Department of Scientific and Industrial Research. It was announced that the Fourth Plenary World Power Conference in London will be held in July 1950 at the house of the Institution of Civil Engineers. The theme of the Conference was approved; it will be "World Energy Resources, and the Production of Power". The future activities of the World Power Conference were discussed, and tentative invitations were received from India, for a sectional meeting to be held in 1951 concurrently with the Fourth Congress of the International Commission on Large Dams of the World Power Conference; and from Italy and Switzerland, who may be the joint hosts at an 'Alpine' Sectional Meeting in 1952 or 1953. The Hungarian delegates suggested a 'Danubian' sectional meeting, to be organised jointly by the national committees of the Danubian countries, on a 'regional' basis. At the request of the Economic and Social Council of the United Nations —which has conferred consultative status upon the World Power Conference—consideration was given to the 'Fuels' and 'Power' Sections of the Provisional Programme of the United Nations Scientific Conference on the Conservation and Utilization of Resources, to be held in the United States in May 1949. It was announced that the first post-war Statistical Yearbook of the World Power Conference will be published shortly; it will contain data on resources and annual statistics covering the eleven years 1936–46. The next meeting of the International Executive Council will be held in Brussels during the first week of July 1949. The new edition of the booklet showing the names of national committees and representatives has been published; copies can be obtained upon application to Mr. C. H. Gray, secretary, International Executive Council, World Power Conference, 201/2 Grand Buildings, Trafalgar Square, London, W.C.2.

Cattle Health and Milk Production

The three Fison Lectures, made possible by the generosity of Messrs. Fisons, Ltd., are part of the educational programme of the Animal Health Trust and were delivered last May by Prof. L. Seekles, of the Veterinary Biochemical School, University of Utrecht. Prof. Seekles chose "Mineral Disturbances of Cattle" as the theme of his first lecture. Our food-producing animals have, he said, become physiologically artificial beings. Experiments carried out in his laboratory strongly suggest that the forced development of the cow as a milk producer causes over-activity of the pituitary gland. Discussing this idea in relation to milk fever, Prof. Seekles suggested that preventive measures against this disease should be designed to prevent over-development of the

pituitary gland during pregnancy. The biochemical features of grass tetany and 'Utrecht abnormality of milk', which results in curdling of the milk of apparently healthy cows during transportation of their milk or when it is boiled, were also discussed. The second lecture, entitled "Gastro-intestinal Auto-intoxication in Cattle and Horses", included a discussion of Dutch methods of treating acetonæmia. Much attention has been recently given to treatment with potassium chlorate, which may be beneficial if the liver is not seriously damaged. Lactate therapy, practised since 1942, has also given good results. The third lecture dealt with the complex subject of real and conditioned deficiencies of trace elements. Evidence has been obtained that in many cases increased motility of the intestine, due to causes independent of the amounts of trace elements in the food, such as the intake of protein and other components of rank spring grass, nematode infestations and paratuberculosis, may cause decreased absorption of trace elements. Intravenous administration of radioactive copper salts had shown that the liver plays an important part in the accumulation of copper. No relation between grass tetany of Dutch cattle and the intake of manganese could be obtained, but significant differences between the manganese content of grass from different soils were noted, the more alkaline soils containing the least manganese.

Earthquakes Registered in New Zealand during February 1948

Six strong earthquakes were registered by the seismographs in New Zealand during February 1948. They were on February 9 (2), 10, 14, 16 and 23, that on February 9 being felt in Anatolia (Turkey). In addition, eighteen local earthquakes were felt in some place in New Zealand during the month. The greatest intensity of any one of these was scale 5 (Modified Mercalli intensity scale) in the Cook Strait region of both islands on February 4, the epicentre being near lat. 40·95° S., long. 173·6° E., and depth of focus approximately 50 km. Earthquakes with scale 4 intensity occurred on February 9 in the Wellington and Wairarapa Regions, on February 18 in the Uruwera District and on February 29 near Lake Coleridge.

Union Catalogue of German Books and Periodicals

Owing to the scarcity of German books and periodicals published since the beginning of the Second World War, the Foreign Office has requested the National Central Library to compile a union catalogue of such of these publications as have reached the United Kingdom. A circular has been issued asking libraries and other institutions to co-operate by amending a check-list indicating their holdings. Anyone who is willing to assist but has not seen the circular should write to the National Central Library (German Union Catalogue), Malet Place, W.C.1.

Geophysics at Hamburg

At Hamburg, the University Meteorological Institute, the Centre for Earthquake Research and the University Institute for Oceanography have been amalgamated to form the Geophysical Institute of the University of Hamburg. The address is now Hamburg 13, Rothenbaumchaussee 33. The new Institute is working under difficulties, and would welcome exchanges of geophysical publications.

Society for the Bibliography of Natural History

At a general meeting of the Society for the Bibliography of Natural History held at the British Museum (Natural History) on February 28 the following officers were elected: *President*, Dr. J. Ramsbottom; *Secretary and Treasurer*, Mr. A. C. Townsend, British Museum (Natural History), Cromwell Road, London, S.W.7; *Committee*, Prof. F. Balfour Browne and Messrs. J. Delacour, W. N. Edwards, F. J. Griffin, Francis Hemming and C. Kirke Swann. It is hoped to revive the activities of the Society, which was founded in 1936, and it was announced at the meeting that a further part of the second volume of the Society's *Journal* is in the press. This consists of a bibliography of whaling by Dr. J. Travis Jenkins. The last part of the *Journal* to be published was Vol. 2, Part 3, issued in April 1946.

Research on Nematology

The Institute of Agricultural Parasitology, Winches Farm, 395 Hatfield Road, St. Albans, Herts, formally ceased to exist as such on September 30, 1947. So far as plant-eelworm work is concerned, its place has been taken by a new Nematology Department of Rothamsted Experimental Station with the following scientific staff: Dr. T. Goodey (head of the Department), Dr. B. G. Peters, Dr. Mary T. Franklin, Mr. D. W. Fenwick, and Mr. J. B. Goodey. From June 30 this Department will be housed at Rothamsted Experimental Station, Harpenden, Herts. Winches Farm is continuing as a field station of the London School of Hygiene and Tropical Medicine, with Mr. J. W. G. Leiper as administrative officer.

University of Leeds

The University of Leeds has received a further grant of £10,000 from the Worshipful Company of Clothworkers, making a total grant of £30,000 to meet the capital cost of the extension of the Textile Industries Department now in course of construction. The British Hat and Allied Feltmakers' Research Association has given £1,000 for research in the same Department.

The following appointments have been made: Dr. F. Henriques, lecturer in social anthropology; Mr. A. N. Greenwood, lecturer in electrical engineering; Mr. C. Kisby, lecturer in textile design.

Commonwealth Fund Fellowships

The list of awards of Commonwealth Fund Fellowships tenable by British graduates in American universities for one year, beginning September 1948, includes the following: E. R. Andrew, Christ's College and Pembroke College, Cambridge, to Harvard University, in physics; J. R. G. Bradfield, Trinity College, Cambridge, to the College of Medicine, University of Illinois, in biology; S. L. Bragg, Trinity College, Cambridge, to the Massachusetts Institute of Technology, in engineering; Dr. Archibald Brown, University of Glasgow and Trinity College, Cambridge, to Yerkes Observatory, University of Chicago, in astronomy; Dr. C. A. Bunton, University College, University of London, to the College of Physicians and Surgeons, Columbia University, in biochemistry; Dr. G. M. Carstairs, University of Edinburgh, to Cornell University, in cultural anthropology; R. B. Hunter, University of Edinburgh, to Johns Hopkins School of Medicine, in medicine; Dr. D. O. Jordan, University of London and University College, Nottingham, to Princeton

University, in chemistry; A. M. Macbeath, Queen's University, Belfast, and Clare College, Cambridge, to Princeton University, in mathematics; G. D. S. MacLellan, Pembroke College, Cambridge, to the Massachusetts Institute of Technology, in mechanical engineering; J. H. Paterson, St. Catharine's College, Cambridge, to the University of Wisconsin, in geography; S. V. Perry, University of Liverpool and Trinity College, Cambridge, to the School of Medicine, University of Rochester, in physiology; R. W. Riddell, University of London, to Duke University, in medicine; Dr. G. A. Smart, University of Durham and University of Bristol, in medicine; I. G. Stewart, University of St. Andrews, to the University of Chicago, in economics; Dr. Alwyn Williams, University College of Wales, Aberystwyth, and University of Cambridge, to the National Museum, Washington, D.C., in geology.

The following have been appointed to Commonwealth Fund Fellowships tenable by candidates from the Home Civil Service: Philip Allen, Queens' College, Cambridge, of the Home Office; R. E. L. Cleaver, New College, Oxford, of the Ministry of Fuel and Power; T. D. Haddow, University of Edinburgh and Trinity College, Cambridge, of the Department of Health for Scotland.

Cambridge Summer Course in Food Science

A SUMMER course in food science will be held in the University of Cambridge, in co-operation with the Department of Scientific and Industrial Research, at the Low Temperature Research Station during August 30–September 11. The whole field of food science will be surveyed, with the view of suggesting the emphasis which should be placed on various aspects in the basic training of scientific workers for the food industries. A substantial knowledge of chemistry, and some knowledge of biology will be assumed. A detailed syllabus and form of application for admission may be obtained from G. F. Hickson, secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, to whom the completed application form should be returned not later than July 10.

International Holiday Centre

THE French Association of Scientific Workers is organising an International Holiday Centre at Morzine (Haute-Savoie) during July 15–September 1. Morzine, without being a fashionable holiday resort, is one of the beauty spots of the French Alps. It lies to the south of Thonon at a height of about 1,000 metres; and around it are ranges rising to about 2,500 metres. So far as hotels are concerned, the French Association of Scientific Workers can secure accommodation at 800 and 700 francs a day (including service and taxes). It has also secured some good camping sites, and is trying to make arrangements for a canteen. Bookings can only be made for whole weeks (from Monday morning to Sunday night) and for a minimum of two weeks; registration fee, 500 francs each person. Applications should be made as soon as possible to the Association des Travailleurs Scientifiques, Maison de l'Université Française, 47 Boulevard St. Michel, Paris 5.

Modern Applications of Liquid Fuels

A JOINT conference, arranged by the Institute of Petroleum and the Institute of Fuel, will be held in the University of Birmingham during September 21–23 to discuss "Modern Applications of Liquid Fuels". The president of the Conference, Mr. J. A. Oriel, will give an address on "The Place of Liquid Fuel in the British Economy"; subsequent sessions will be devoted to the discussion of papers circulated in advance on fuel oil in the steel industry, other metal industries, glass and ceramic industries; domestic heating; gas turbines for land and marine power purposes; agricultural drying processes; diesel engines; and oil for gas making. Further particulars can be obtained from the general secretary, R. W. Reynolds Davies, 18 Devonshire Street, London, W.1.

Announcements

THE Minister of Fuel and Power has appointed Dr. H. Roxbee Cox, at present director of the National Gas Turbine Establishment, to be chief scientist at the Ministry of Fuel and Power. Sir Alfred Egerton, professor of chemical technology at the Imperial College of Science and Technology, London, has accepted the invitation of the Minister to be chairman of the Scientific Advisory Council which will be set up to advise him on the scientific aspects of his statutory duties.

SIR NORMAN HAWORTH, Mason professor of chemistry and director of the Department of Chemistry in the University of Birmingham, retires at the end of the present session under the age limit. He is to be succeeded by Prof. H. W. Melville, professor of chemistry in the University of Aberdeen. Dr. K. Mather, head of the Genetics Department of the John Innes Horticultural Institution, Merton, has been appointed to the newly established chair of genetics at Birmingham.

MR. J. E. CUMMINS, formerly officer-in-charge of the Information Service of the Council for Scientific and Industrial Research, has been appointed chief scientific liaison officer for Australia in London. He expects to remain in the United Kingdom for about five years, and will direct the future work of the Australian Scientific Research Liaison Office.

AWARDS from the Daniel-Pidgeon Fund have been made by the Council of the Geological Society of London to Dr. J. S. Webb, who proposes to investigate the tin–tungsten mineralization in the Hercynian geosyncline as exposed in western Europe, and to Mr. W. S. McKerrow, who proposes to undertake a statistical investigation of the variation of the brachiopods from fullers' earth.

THE Council of the University of Sheffield has made the following appointments: J. C. Gilbert, senior lecturer in economics; A. Gilbert, lecturer in psychology; J. H. Davies and S. J. Langley, assistant lecturers in economics; Brian E. Heard, assistant lecturer in pathology; Peter Freeman, research assistant to the professor of engineering.

THE second annual exhibition organised by the Birmingham Branch of the Society of Inventors will be held in the Chamber of Commerce Building, Birmingham, during October 25–30. The object of the exhibition is to show manufacturers and members of the public new devices that have been produced during the year. Entries for the exhibition are accepted both from members of the Society and from non-members. Anyone wishing to enter an exhibit, which must be either patented, protected or of registered design, should write to the secretary, Mr. B. Thornton Clark, 244 Stoney Lane, Yardley, Birmingham 25.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Amino-Acid Metabolism of Tissue Cells *in vitro*

EMPLOYING a technique which at the time was far from being perfect, we were able in 1941 to demonstrate the general importance of amino-acids in connexion with the maintenance and growth of tissue cells[1]. It was found that cystine occupies a key position among the amino-acids; if absent from a diet that contains all the other amino-acids, the cells cannot be kept alive, but die within twenty-four hours. The relative significance of the other amino-acids could not at the time be tested similarly, because of the imperfection of our technique.

The technique has now been improved. Practically normal growth of cells has been obtained in a synthetic medium on a basic diet consisting of groups of substances known empirically to be of significance to the whole organism, namely, amino-acids[2], the methylating system, the SH–SS system, the vitamins, choline, creatine and the C_4-acids functioning in the Krebs cycle. If amino-acids are lacking in this basic diet, it is impossible to keep the cells alive in the dialysed plasma medium for any length of time.

In order to gain information regarding the importance of the individual amino-acids in Rose's mixture, the following technique was employed. Control cultures were kept on the basic diet including the whole series of amino-acids: lysine, arginine, tryptophane, methionine, histidine, glutamic acid, aspartic acid, proline and cystine. Experimental mixtures were then prepared, leaving out the one amino-acid the significance of which was to be investigated. Fig. 1 illustrates the growth of myoblasts in the control mixture, and in the experimental mixture, which in this case had lysine omitted; the lysine deficiency caused only a slight reduction in the rate of growth as compared with that of the control. The same experiment on osteoblasts showed these cells to be much more sensitive to lysine deficiency than myoblasts (Fig. 2). Apparently this amino-acid is more essential to osteoblasts than to myoblasts.

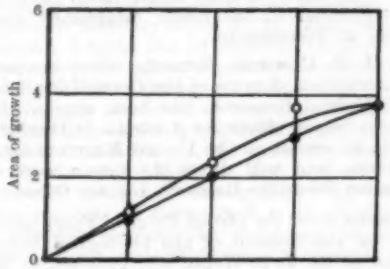

Fig. 1

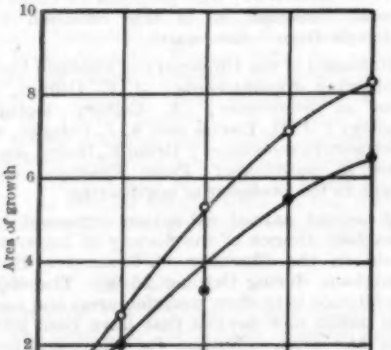

Fig. 2

Each one of the amino-acids mentioned above has been tested in our experiments. If graded according to the difference in growth between the control culture (in which the medium contains the complete set of amino-acids) and the experimental culture with one of the amino-acids omitted, the following sequence is obtained (Fig. 3).

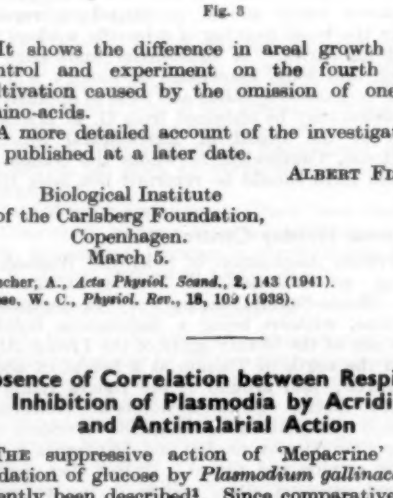

Fig. 3

It shows the difference in areal growth between control and experiment on the fourth day of cultivation caused by the omission of one of the amino-acids.

A more detailed account of the investigation will be published at a later date.

ALBERT FISCHER

Biological Institute
of the Carlsberg Foundation,
Copenhagen.
March 5.

[1] Fischer, A., *Acta Physiol. Scand.*, **2**, 143 (1941).
[2] Rose, W. C., *Physiol. Rev.*, **18**, 109 (1938).

Absence of Correlation between Respiratory Inhibition of Plasmodia by Acridines and Antimalarial Action

THE suppressive action of 'Mepacrine' on the oxidation of glucose by *Plasmodium gallinaceum* has recently been described[1]. Since comparatively large concentrations of the drug (1 in 6,000) were necessary to produce an appreciable inhibition of respiration, it is questionable whether this effect is a measure of the specific antagonistic reaction responsible for the *in vivo* antimalarial properties of 'Mepacrine'.

More information on this point has now been obtained by comparing the inhibitory effects of the following acridines: 5-aminoacridine, 'Mepacrine' (2-chloro-7-methoxy-5-(δ-diethylamino-α-methylbutyl)aminoacridine), and the intermediate substance, 2-chloro-7-methoxy-5-aminoacridine. The accompanying table shows the action of these three acridines on the oxygen uptake of heavily parasitized, washed

COMPARISON OF EFFECTS OF ACRIDINES ON PLASMODIAL RESPIRATION, MAMMALIAN TOXICITY AND ANTIMALARIAL ACTIVITY

Compound	Mol. wt. of substance	% inhibition of oxygen uptake of *P. gallinaceum* (Conc. 1 in 6,000)	Toxicity; $L.D._{50}$, mice, subcutaneous (gm./kgm., base)	Antimalarial activity; quinine equiv. (*P. gallin.*)
5-Aminoacridine, HCl,H_2O	248	80·5 78·0 73·0	0·08	<0·02
2-Chloro-7-methoxy-5-aminoacridine (free base dissolved in acetic acid)	259	78·5	0·11	<0·06
2-Chloro-7-methoxy-5-(δ-diethylamino-α-methyl-butyl) aminoacridine, $2HCl,2H_2O$ ('Mepacrine')	508	38·6 44·4 43·3	0·28	2 to 6

chick red cells, suspended in buffered saline containing glucose. The concentration of acridines in the respirometer flasks was 1 in 6,000 of the compounds as tabulated. The toxicities to mice[2] and the antimalarial action *in vivo* against chicken malaria[3] are also included.

It will be seen that the *in vitro* inhibitory action of the less complex molecules is greater, weight for weight, than that of 'Mepacrine', and follows more closely the order of general systemic toxicity rather than the *in vivo* antimalarial action, which is in the reverse order. These results indicate that the observed inhibitory action of 'Mepacrine' on the respiration of the malarial parasite may represent the toxicity which high concentrations of acridines exert on living cells in general, but not the specific action of 'Mepacrine' on the malarial parasite.

ADRIEN ALBERT
P. B. MARSHALL

Wellcome Research Institution,
183–193 Euston Road,
London, N.W.1.
March 2.

[1] Marshall, P. B., *Brit. J. Pharmacol.*, **3**, 1 (1948).
[2] Rubbo, S. D., *Brit. J. Exp. Path.*, **28**, 1 (1947).
[3] Wiselogle, F. Y., "Survey of Antimalarial Drugs, 1941–45" (J. W. Edwards, Ann Arbor, Michigan, 1946).

Studies with Radioactive Penicillin

THE work of Gale[1] points to the possibility that penicillin may act by depriving sensitive organisms of glutamic acid, which is probably essential to their life. The present work was instituted to find out whether penicillin, by being itself adsorbed, blocks the passage of glutamic acid through the cell wall.

Whatever the mode of action of penicillin, it is to be expected that there would be a quantitative relationship between the amount of penicillin and the number of bacteria killed by it. Several workers have attempted to measure the amount of penicillin directly involved in the killing of a certain number of susceptible bacteria[2], but without success, as the amount of penicillin, if any, taken up by the organisms is too small to detect by biological methods. By using radioactive penicillin of a high specific activity, it should be possible to detect any uptake of penicillin by the bacteria.

For the preparation of the radioactive penicillin, we used 0·1 millicurie of S^{35} present in 0·014 mgm. of sulphur. This was diluted to a total of 0·109 mgm. of sulphur in order to give 2 ml. of broth in all. The medium used was based on that recommended by Jarvis and Johnson[3], modified by reducing the sulphur content to 0·0055 per cent, at which point sulphur became the factor limiting penicillin yield. After autoclaving, the medium was inoculated with a vegetative culture of the *Q* 176 strain of *P. chrysogenum* and was shaken for four days at 24° C. in a 50 ml. conical flask. After filtration, the penicillin was extracted from the cooled broth with ether and re-extracted into dilute phosphate buffer at *p*H 7·5. The solution was adjusted to *p*H 6, and 0·1 per cent of sodium hexametaphosphate was added to stabilize the penicillin[4]. The yield was 250 I.U. of penicillin, representing a 12 per cent conversion of the sulphur in the broth into penicillin with a specific activity of 0·05 microcurie per I.U.

It is perhaps noteworthy that the presence in the medium of 50 millicuries of S^{35} per litre did not adversely affect the growth of the mould.

The preparation of radioactive penicillin with a very much weaker specific activity has recently been reported from the United States[5], using 272 litres of broth containing 24·2 millicuries of S^{35}. They obtained 3·4 per cent conversion of the sulphur into penicillin with an activity of 0·00006 microcurie per I.U.

The radioactivity of the penicillin was measured by means of a Geiger-Müller counter, having a background rate of 14 counts per minute. The activity of a sample producing a counting-rate of 50 per minute could therefore be measured with an error of ± 3 per cent in a little more than an hour. Correcting for absorption of the radiations in the material of the sample, it was possible, in this time, to measure 0·004 I.U. of penicillin with an error of ± 5 per cent.

For the absorption experiments *Staphylococcus aureus* was grown on agar plates at 37° C. for 9 hours, scraped off, transferred in sufficient quantity to 25 ml. broth, so as to give a thick suspension, and incubated for a further 2 hours. A measured amount of radioactive penicillin was then added, and an aliquot portion of the suspension removed for radioactive assay; this removal of a standard volume of the suspension was repeated at intervals as a control. During the course of an experiment, these samples should give equal counts. After ½, 2, 6 and 24 hours, 5 ml. of the suspension was removed and filtered through a 'Gradocol' membrane and washed through with 2 ml. water into a graduated receiver. Aliquot portions of these filtrates were taken, dried on planchettes, weighed and counted. Any uptake of penicillin by the bacteria should be manifested by a decrease in penicillin concentration in the filtrate.

The accompanying table gives the results of an experiment in which 0·07 I.U. per ml. was employed in a suspension containing approximately $3·2 \times 10^9$ viable organisms per ml.; after 24 hours there were $0·24 \times 10^9$ viable organisms per ml.

Time (hr.)	Actual count per min. minus background		Count per 200 c.mm. per min. fully corrected		Penicillin units per ml.	
	A	*B*	*A*	*B*	*A*	*B*
0	36	42	49	48	0·068	0·067
½	33	41	45	48	0·063	0·067
2	31	37	43	43	0·060	0·060
6	41	40	43	46	0·060	0·064
24	36	36	47	42	0·066	0·059

A represents filtrates. *B* represents suspension.

From these results it is seen that the greatest difference between the penicillin concentrations in the filtrates is no greater than that for the suspensions; the latter difference represents experimental error.

Corresponding results were obtained from other experiments, where the penicillin concentration varied from 1 down to 0·05 unit per ml. From these experiments it is possible to say that absorption of penicillin, if any, probably amounts to less than ten molecules per bacterium.

The work is continuing, and further details of it will be published elsewhere.

We should like to thank Sir Alexander Fleming for his interest in this work, the Medical Research Council for the gift of the S^{35}, and Dr. W. F. Widdas for help with the construction of the counter.

D. Rowley
J. Miller
Wright-Fleming Institute of Microbiology,
St. Mary's Hospital, London, W.2.
S. Rowlands
Physics Department,
St. Mary's Hospital, London, W.2.
E. Lester-Smith
Research Division,
Glaxo Laboratories, Ltd.,
Greenford, Middlesex.
May 4.

[1] Gale, E. F., and Taylor, E. S., *J. Gen. Microbiol.*, **1**, 314 (1947).
[2] Hobby, G. L., Meyer, K., and Chaffee, E., *Proc. Soc. Exp. Biol., N.Y.*, **50**, 281 (1942).
[3] Jarvis, F. G., and Johnson, M. J., *J. Amer. Chem. Soc.*, **69**, 3010 (1947).
[4] Lester-Smith, E., *Quart. J. Pharm.*, **19**, 309 (1946).
[5] Howell, S. F., Thayer, J. D., and Labow, L. W., *Science*, **107**, 299 (1948).

Effect of Antibacterial Analogues of Vitamin K on *M. tuberculosis*

I would like to record some experiments made three years ago and recently repeated with a different technique. During a search for chemically defined growth-factors for *M. tuberculosis*, it was decided to investigate vitamin K. The role of vitamin K in bacterial metabolism has not been determined; but this vitamin is present in many organisms and is probably of nutritional importance[1,2,3]. Anderson has isolated from a laboratory strain of human tubercle bacillus a pigment, 'phthiocol' (2 methyl 3 hydroxy 1 : 4 naphthoquinone), which has vitamin K-like activity[4,5]. It has been postulated that phthiocol is derived from vitamin K during the extraction of the bacteria[6]. For many years it has been known that *M. paratuberculosis* when freshly isolated will grow only on media containing extracts of other acid-fast bacteria, notably *M. phlei*. The claim has been made that phthiocol and 2 methyl 1 : 4 naphthoquinone can replace *M. phlei*[7]; but the stimulant action is not so marked, and hence it does not follow that the *M. phlei* growth-factor and these compounds are the same. *M. tuberculosis* var. *hominis* can also have its growth accelerated by extracts of other acid-fast bacteria, and for these reasons this investigation was undertaken. Reports in the literature on the action of phthiocol and 2 methyl naphthoquinone are not consistent[8,9], but naphthoquinone derivatives have been claimed as inhibitory[10]. In the accompanying table compounds 1 and 2 are water-soluble synthetic vitamin K derivatives and both inhibit growth.

Medium: Long's plus Tween 80, 0·01 per cent; bovine plasma fraction V, 0·2 per cent. Inoculum: 1 mgm. virulent *M. tuberculosis* var. *hominis*

Compound	Amount causing inhibition at eight days	
	Molarity	Parts per million
1 4 Amino 2 methyl 1 naphthol hydrochloride	10^{-4}	3
2 Tetrasodium 2 methyl 1 : 4 naphthohydroquinone diphosphate	4×10^{-4}	166
3 Quinoxaline di N-oxide	2×10^{-4}	33
4 2 Methyl quinoxaline di N-oxide	5×10^{-4}	80
5 Methyl pentyl quinoxaline di N-oxide	10^{-4}	25
6 2 Hydroxy quinoxaline	5×10^{-3}	1000
7 1 : 2 : 3 : 4 : Tetrahydrophenazine di N-oxide	2×10^{-4}	20
8 1 : 2 : 3 : 4 : Tetrahydrophenazine	5×10^{-4}	100
9 Phenazine mono N-oxide	10^{-4}	25
10 Phenazine di N-oxide	5×10^{-6}	1
11 Dihydroxy phenazine di N-oxide (iodinin) (impure preparation)	10^{-4}	2

As recently isolated virulent strains of *M. tuberculosis* require complex media of unknown composition, an indirect approach to the problem was sought by the use of antibacterial analogues of the vitamin K series. Such compounds have been made by McIlwain[3], and their effect is shown in the table. The results are parallel to those obtained with other organisms, and I have obtained similar but not identical results with different culture substrates. The phenazine derivatives are of interest because of their relation to the bacterial pigments pyocyanine and chlororaphin, and iodinin itself is obtained from *Chromobacterium iodinum*. Compound 10 is non-toxic to guinea pigs and mice, and *in vivo* tests are now in progress.

Thus the original hypothesis that vitamin K-like compounds are necessary for the nutrition of *M. tuberculosis* has not been proved; but the results listed do suggest that similar substances play some part in the metabolism of the organism. Recent advances in vitamin K research may have an application to this problem[11,12,13].

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C. N. Iland
Department of Bacteriology,
University, Birmingham.
Feb. 24.

[1] Butt, H. R., and Osterberg, A. E., *J. Nutrition* (Suppl.), **15**, 11 (1938).
[2] Almquist, H. J., *et al.*, *Proc. Soc. Exp. Biol. and Med.*, **38**, 336 (1938).
[3] McIlwain, H., *J. Chem. Soc.*, 322 (1943).
[4] Anderson, R. J., and Newman, M. S., *J. Biol. Chem.*, **101**, 773 (1933).
[5] Anderson, R. J., and Newman, M. S., *J. Biol. Chem.*, **103**, 197 (1933).
[6] Evans, E. A., "Biological Action of Vitamins", Symposium Univ. Chicago, 203 (1942).
[7] Wooley, D. W., and McCarter, J. R., *Proc. Soc. Exp. Biol. and Med.*, **45**, 357 (1940).
[8] Edson, N. L., *et al.*, *Biochem. J.*, **137**, 5, 563 (1943).
[9] Steenken, W., and Heise, F. H., *Amer. Rev. Tub.*, **44**, 635 (1941).
[10] Lloyd, J. B., and Middlebrook, G., *Amer. Rev. Tub.*, **49**, 539 (1944).
[11] Smith, D. G., and Robinson, H. J., *Proc. Soc. Exp. Biol. and Med.*, **57**, 292 (1945).
[12] Milklin, D. M., *C.R. Acad. Sci. U.R.S.S.*, **37**, 191 (1942).
[13] Davidson, C. S., and Macdonald, H., *New Eng. J. Med.*, **229**, 353 (1943).

Dicumarol Poisoning and Vitamin K Deficiency in Relation to Quick's Concept of the Composition of Prothrombin

In 1943, Quick[1] published some experiments which were taken as evidence for the multiple nature of prothrombin. In the same paper Quick expressed the opinion that the hypoprothrombinæmia in vitamin K deficiency might be due to the disappearance of the same constituent of prothrombin as that which is lacking in dicumarol poisoning, namely, the component which is relatively stable during storage.

Shortly after the appearance of the above-mentioned paper, I carried out a few simple experiments in order to establish whether these two forms of hypoprothrombinæmia are due to the lack of one and the same factor, as suggested by Quick.

The experiments consisted in mixing the plasma from vitamin K – deficient chicks with plasma from chicks poisoned with dicumarol and determining the clotting time by the addition of diluted chicken thromboplastin. If the components lacking in the two kinds of plasma were different, suitable mixtures of the plasmas should clot almost as fast as normal chicken plasma in the circumstances chosen. This was not found to be the case, the clotting times of the mixtures lying largely in the interval between the clotting times of the two different plasmas.

Recently, Quick[1] has elaborated his hypothesis on the nature of prothrombin further, and now claims that the relatively stable component consists of two factors. He suggests that dicumarol poisoning is concerned with one of these factors and vitamin K deficiency with the other. The simple experiments mentioned above show that a difference between the two forms of hypoprothrombinæmia cannot consist *merely* in the absence of one factor in dicumarol poisoning and of another in vitamin K deficiency in such a way that the clotting anomaly will be compensated by mixing the two plasmas.

HENRIK DAM

Department of Biology,
Polytechnic Institute,
Copenhagen.
March 8.

[1] Quick, A. J., *Amer. J. Physiol.*, **140**, 212 (1943).
[2] Quick, A. J., *Amer. J. Physiol.*, **151**, 63 (1947).

Chemical Breakage of Chromosomes

IN a paper under the above title, Darlington and Koller[1] have analysed the close similarity between chemical and radiation-induced breakage of chromosomes, and have rejected the physical 'target' theory of the X-ray phenomenon as propounded[2] by the late Dr. D. E. Lea[3]. First, they criticize the data on which this theory was based, asserting that "temperature control has been largely dispensed with in the experiments used by Lea as evidence"; and secondly, they conclude that "it is scarcely possible to doubt that both X-rays . . . and chemical breakage are immediately determined by chemical processes which in the X-ray case intervene between an ionization and breakage". In fairness to Lea, we feel that we should point out that neither of these statements is a valid criticism of the target theory. The effects of temperature on radiation-induced breakages have been taken into consideration, and it has been almost axiomatic among physicists that chemical processes follow on the initial act of ionization.

Sax[3] demonstrated that the yield of structural changes during X-irradiation is dependent upon the temperature of the material at the time of exposure, but is independent of the temperature before and after the exposure. Experiments by Lea and Catcheside, which will be reported in detail elsewhere, corroborate this result. Flowering shoots of *Tradescantia* were maintained at the same constant temperature before and after irradiation with X-rays and were irradiated at temperatures between 1° and 30° C. Fixations of dividing pollen grains were made at a series of times subsequent to irradiation. By this means the frequency of structural changes in relation to the rate at which mitosis proceeded after different treatments could be followed. The highest yield of structural changes was observed in the material irradiated at the lowest temperature; but the rate at which mitosis proceeded when the shoots were restored to their standard temperature after irradiation was independent of the temperature at which they had been irradiated. On the other hand, if the shoots were kept at a high temperature in the period after irradiation, mitosis was speeded up, so that the irradiated cells took a shorter time to reach metaphase; but the final yield of structural changes was not affected. This latter effect was recognized by Darlington and La Cour[4], who, however, did not observe the dependence of yield on the temperature during the irradiation.

Giles[5] irradiated *Trodescantia* pollen grains with neutrons, and found that two-break structural changes were independent of intensity. With X-rays such structural changes are less frequent per unit dose at lower intensities. This result with neutrons shows that breakage is almost instantaneous, and affords clear evidence that breakage occurs inside the ionization track. The observation with X-rays that either a lower temperature during irradiation or a higher intensity favours new unions as against old unions (restitutions), even though the treatment occupies only a few minutes, shows that the rearrangements are mostly completed within a short time of the irradiation.

That chemical processes form part of the sequence of changes which occur between an ionization and its biological effect was stated explicitly by Crowther in his Silvanus Thompson Memorial Lecture ten years ago. Discussing the target theory, he said, "the majority of upholders of the target theory would tend to look to chemical action as the first link in the chain"[6]. The point at issue is not whether chemical changes are involved or not, but where these changes start[7]. In the case of chromosome breaks, Lea's theory postulates that they must start inside, or within a few millimicrons of, the track of a single ionizing particle[8]. This conclusion was based on analyses of the relationship between the number of chromosomes affected and the dose of radiation administered, of the effect of varying the dosage-rate of the radiation, and of the effects produced by different types of radiation. It provides a satisfactory quantitative prediction of the biological phenomena under each of these headings. Recent work by Weiss[9], based on the hypothesis that ionization in an aqueous medium releases free hydrogen and hydroxyl radicals, shows that, quantitatively, the phenomena are consistent with interaction of hydroxyl radicals with large 'receptor' molecules: but an investigation by Lea[10] of the kinetics of the recombination of hydrogen and hydroxyl radicals led to the conclusion that the chemical effects of α-particles would be confined to the immediate vicinity of the α-ray tracks, though a rather wider range might be possible with X-rays. So far, the chemical approach has provided no specific mechanism by which hydroxyl radicals produced by ionizations outside the range postulated by the target theory could cause the observed biological changes in the same quantitative way. Until it has done so—and many workers in this field believe that it ultimately will—the target theory must be retained

as the most satisfactory working hypothesis of the origin of the phenomena.

C. B. Allsopp

Guy's Hospital Medical School,
London, S.E.1.

D. G. Catcheside

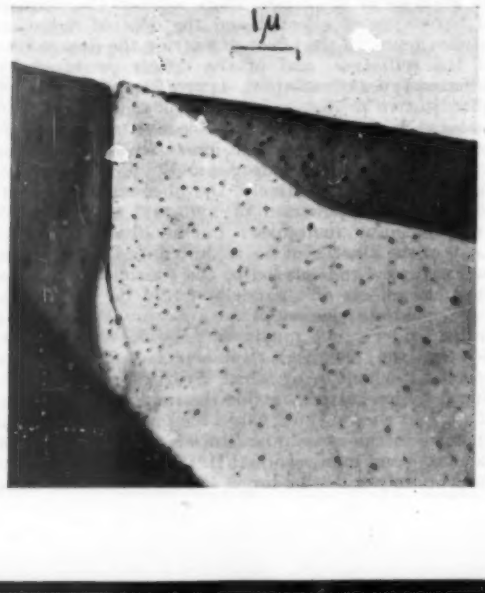
Botany School,
Cambridge.
March 8.

[1] Darlington, C. D., and Koller, P. C., *Heredity*, **1**, 187 (1947).
[2] Lea, D. E., "Actions of Radiations on Living Cells" (Camb. Univ. Press, 1946).
[3] Sax, K., *Genetics*, **32**, 75 (1947).
[4] Darlington, C. D., and La Cour, L. F., *J. Genet.*, **46**, 180 (1945).
[5] Giles, N. H., *Genetics*, **28**, 398 (1943).
[6] Crowther, J. A., *Brit. J. Rad.*, **11**, 144 (1938).
[7] Allsopp, C. B., *Brit. J. Rad.*, **21**, 72 (1948).
[8] Lea, D. E., *Brit. J. Rad.*, Supp. No. 1, 75 (1947).
[9] Weiss, J., *Brit. J. Rad.*, Supp. No. 1, 56 (1947); *Trans. Farad. Soc.*, **43**, 314 (1947).
[10] Lea, D. E., *Brit. J. Rad.*, Supp. No. 1, 59 (1947).

Electron Microscopy of the Sarcolemma

Striated muscle fibres are surrounded by a delicate membrane or sheath, the sarcolemma. It has frequently been stated[1,2,3] that this sheath is composed of a network of collagenous or reticular fibrils, arranged like a knitted sock. One of us (R. B.) in an investigation to be described elsewhere has failed to find any evidence of fibrillar structure using various methods of microscopy, including phase contrast and dark-ground illumination. We have, therefore, investigated the structure of the sarcolemma by means of the electron microscope (R.C.A. console model).

Frog's thigh muscles were teased roughly and allowed to soak for periods of up to a few hours in Ringer's solution. This produces numerous retraction clots in the fibres, leaving clear areas of empty sarcolemma. The fibres were then fixed or treated with various chemical reagents and dried in a desiccator. Unfixed fibres were also examined. After drying, the fibres were mounted on the usual 200-mesh specimen grid of the electron microscope. The accompanying photograph shows a strip of sarcolemma (formalin fixed) × 11,000 (initial magnification in microscope 5,000 times). No fibrils were seen at magnifications up to 25,000. The main feature is the presence of numerous small spots, of the order of 0·04–0·1 μ in diameter. In places where the membrane has become folded it appears that the spots lie *on* the membrane rather than *in* it. In some cases the spots seemed to form a more or less regular pattern, but this may not always appear to be the case owing to distortion of the membrane. The spots were seen in unfixed material, but were clearer after formalin fixation. Sheets of membrane were often observed to split under the action of the beam; the membrane tears linearly and cleanly without leaving fibrous strands, in marked contrast to high-polymer membranes which have frequently been studied by the electron microscope.



The nature of the spots is at present unknown. They are not seen in specimens which have been treated for some hours with dilute citric acid. It is possible that they might be points of attachment of either connective tissue fibrils or myofibrils. They are usually about 0·5 μ (or less) apart, a distance which does not correspond to any known periodicity within the myofibril; but it is possible that the sarcolemma has become shrunk or distorted by drying. The thickness of the sarcolemma is usually given as 1 μ. Electron microscopy suggests that it may be less than 0·1 μ, though a tenfold shrinkage is not ruled out.

These experiments are still in an early stage. The work is being continued with improved technique and a more detailed account will appear elsewhere.

We wish to thank the Ministry of Supply for the facilities which enabled us to carry out the investigation.

W. M. Jones

Atomic Energy Research Establishment,
Harwell.

Robert Barer

Department of Human Anatomy,
Oxford.
March 9.

[1] Bairati, A., *Z. Zellforsch.*, **27**, 100 (1937).
[2] Nagel, A., *Z. Zellforsch.*, **22**, 694 (1935).
[3] Fenn, W. O., Contractility in Höber's "Physical Chemistry of Cells and Tissues" (Churchill, 1945).

Capillary Distribution in Cow Skin

In studies on the nature and distribution of the 'sweat' glands of Ayrshire cows, shortly to be published in detail elsewhere, a close relationship has been found between the distribution of blood capillaries and hair follicles.

Other workers[1–3] have been concerned with all or some of the following structures, (1) the hair follicle, (2) the sebaceous gland located near the middle of the hair follicle and opening into it, (3) the arrector pili muscle and (4) the 'sweat' gland lying at the base of the hair follicle and with independent duct opening on the surface of the skin close to the point of emergence of the hair. The number of hairs has been used as an index of the number of 'sweat' glands in different regions of the skins of buffaloes, Zebu, Formosan and Freisian cattle[1].

These structures appear to form a unit, and in our observations on twenty-one different skin regions of each of five four-year-old Ayrshire cows, we have been unable to find any one of these structures not associated with the others. This also applies to

Fig. 1. VERTICAL SECTION OF CALF SKIN IN THE FLANK REGION. × 80. DELAFIELD H.-E. STAIN

A, sebaceous gland; *B*, 'sweat' gland; *C*, hair follicle; *D*, arrector pili; *E*, 'sweat' gland duct; *F*, emergence of hair; *G*, epidermis.

I, sub-epidermal level; II, sebaceous gland level; III, sub-sebaceous gland level; IV, 'sweat' gland level; *V*, sub-'sweat' gland level

the calves and embryos we have studied. The number of hairs per unit area of skin surface may therefore be taken as a direct index of the number of any of these four structures per unit area.

Cow skin may be divided into two distinct layers: the epidermis and the corium. In the corium the following five levels may easily be identified: (1) the sub-epidermal level roughly corresponding to the papillary layer and uppermost portion of the reticular layer of human skin, although in cow skin papillæ are generally absent and when present are not so prominent as in human skin; (2) the sebaceous gland level; (3) the sub-sebaceous gland level; (4) the 'sweat' gland level; and (5) the sub-'sweat' gland level. The latter four levels are all in the reticular layer. These levels and the structures referred to are shown in Fig. 1.

In the sub-epidermal level fine-calibre capillaries anastomose to form a network each loop of which encircles a hair follicle as seen in Figs. 2 and 3. This network is located in a position similar to that of rete subpapillare in human skin. In the sebaceous gland level this does not occur, though capillaries or fine arterioles running from the sub-sebaceous gland level almost vertically to the sub-epidermal level supply the sebaceous gland through fine branches. In the sub-sebaceous gland level and in the 'sweat' gland level the capillaries surround groups of two or more hair follicles, as seen in Fig. 4. In the sub-'sweat' gland level arterioles and venules are found but are few in number.

Since every hair follicle possesses a capillary loop, in the sub-epidermal level the number of capillary loops is directly related to the number of hair follicles. According to our microscopic counts for one of these cows, the number of hair follicles per sq. cm. of skin surface was 940 ± 73 in the sacral region of the back and 3,000 ± 255 in the lateral region of the neck. The average diameter of the capillaries associated with each hair follicle in the sub-epidermal level was 0·086 ± 0·030 mm. for the sacral region of the back and 0·040 ± 0·005 mm. for the lateral region of the neck. The average circumference of the capillary loops was 1·043 ± 0·255 mm. for the sacral region of the back and 0·758 ± 0·089 mm. for the lateral region of the neck.

The capillary surface per sq. cm. of skin surface in the sub-epidermal region may be calculated by means of the equation:

$$S = \frac{\pi dC}{2} \times n,$$

where S is the capillary surface per sq. cm. of skin surface, d is the average diameter of the capillaries, C is the average circumference of the capillary loops and n is the number of hair follicles per sq. cm. of skin surface in the chosen region. Since πdC is the capillary surface area of the whole loop, the area of the loop associated with one hair follicle (because of loop sharing) is $\pi dC/2$.

Hence the capillary surface per sq. cm. of skin surface may be calculated to be 1·33 sq. cm. for the sacral region of the back and 1·43 sq. cm. for the lateral region of the neck.

These calculations, of necessity, make no allowance for distortion during histological preparation or for physiological variation during life.

Hairs in the same skin site generally slope in one direction and the hair follicles incline to one side, forming an acute angle with the epidermis. The arrector pili muscle, the sebaceous gland and the 'sweat' gland are located in the obtuse angle. Hence, when the arrector pili muscle contracts, as in conditions of external cold, pressure will be exerted on the capillaries. This will probably supplement cutaneous vasoconstriction under such conditions and the peripheral blood flow will be reduced with consequent increased heat conservation. This function of the muscle is additional to its function in increasing heat insulation by the erection of hair. In human skin this latter function adds little to heat conservation but the capillary constriction effect may yet remain.

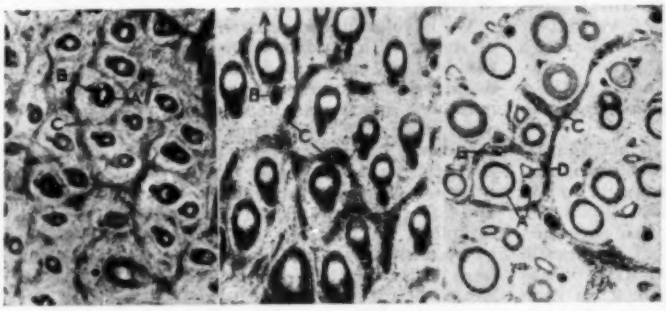


Fig. 2 Fig. 3 Fig. 4

Fig. 2. SUB-EPIDERMAL LEVEL OF COW SKIN. FOREHEAD REGION. × 40. *A*, hair follicle; *B*, 'sweat' gland duct; *C*, capillary

Fig. 3. SUB-EPIDERMAL LEVEL OF COW SKIN. LUMBAR REGION. × 33. *A*, hair follicle; *B*, 'sweat' gland duct; *C*, capillary

Fig. 4. 'SWEAT' GLAND LEVEL OF COW SKIN. FOREHEAD REGION. × 40. *D*, 'SWEAT' GLAND. OTHER DATA AS IN FIG. 2

These studies form part of a project on the acclimatization of dairy cattle being undertaken at this Institute.

J. D. FINDLAY
S. H. YANG*

Hannah Dairy Research Institute,
Kirkhill, Ayr.

* Scholar of the Sino-British Cultural and Educational Fund.

[1] Yamane, J., and Ono, Y., *Mem. Fac. Sci. Univ. Tohoku*, **19**, 87 (1936).
[2] Dempsey, M., *Nature*, **157**, 513 (1946).
[3] Dempsey, M., "Progress in Leather Science", **1**, 3 (1946).

Relation of Enamel Protein to Dental Caries

I MADE some observations on the nature of enamel protein in 1936 [1]. The possible role of enamel protein in the production of caries is described below.

(*a*) Micro-analysis of enamel protein (Weiler) gave N 12·1 per cent, S 1·2 per cent; other nitrogen determinations (Schoeller) were 9·2 and 11·1 per cent. Levene[2] gives nitrogen determinations for mucoproteins as ranging from 6·7 to 13·3 per cent; nitrogen values for proteins are generally accepted as 12–18 per cent.

(*b*) Sections of developing human enamel stained with thionin provide evidence of limited value of the presence of material resembling mucin. Wassermann[3] has illustrated the secretion of globular material by the enamel-forming cells, the ameloblasts, in guinea pigs.

(*c*) A substrate resembling chondroitin sulphuric acid by qualitative tests has now been prepared from dentine by the use of calcium chloride[4]. Dentine is reduced to powder by the use of a dental engine and a bur, defatted with acetone and ether, and extracted with 10 per cent calcium chloride; the extract is deproteinized with a chloroform – amyl alcohol mixture and centrifuged. Chondroitin sulphuric acid is separated from the supernatant liquid by alcohol and glacial acetic acid, then washed with alcohol. A solution of chondroitin sulphuric acid prepared in this manner reduced Fehling's solution, and was not fermented by yeast. No pentose was detected; naphthoresorcinol gave a brown to purple colour; phloroglucinol a red colour. No free sulphate was detected.

From this substrate, enzymes of a Gram-negative bacillus in pure culture have been found capable of quantitative release of sulphate. The organism used is No. 3247, National Collection of Type Cultures, *Ps. non-liquefaciens*. Neuberg[5] has described three sulphatases in Gram-negative bacilli, of which two are of interest in connexion with the present work: chondrosulphatase, which releases sulphate quantitatively fron chondroitin sulphuric acid, while a similar type of enzyme releases sulphate from the mucoitin sulphuric acid of mucin.

An explanation of caries developing in enamel may be as follows. Enamel protein resembles a mucoprotein in its properties. Gram-negative bacilli, commonly found in caries, can release sulphatase. Enamel is made up of hexagonal prisms each surrounded by a sheath of enamel protein. Enzymatic hydrolysis of these sheaths in caries, with release of sulphuric acid, would result in attack on each prism from the periphery inwards; the relatively insoluble calcium phosphate which forms the inorganic part of the enamel would be slowly changed to the relatively soluble calcium sulphate. It is of interest to notice that Frisbie *et al.*[6] show enamel caries proceeding in just such a manner, each prism decreasing in size from the outer edge inwards.

To summarize: (1) quantitative estimations of nitrogen and of sulphur, together with evidence from the developmental aspect and from histochemical tests, suggest that enamel protein is a mucoprotein; (2) the presence of a chondrosulphatase in certain Gram-negative bacilli is confirmed; (3) the mode of progress of caries in enamel, studied histologically, can be accounted for by the present hypothesis.

The Medical School of the Middlesex Hospital gave facilities for this work through the kindness of Prof. Samson Wright. Dr. Alan Morgan, Westminster Hospital Medical School, kindly gave access to histological material. The Medical Research Council provided financial assistance. Grateful thanks is made for these facilities.

PAUL PINCUS

Department of Physiology,
Middlesex Hospital Medical School,
London, W.1.
March 12.

[1] Pincus, P., *Nature*, **138**, 970 (1936).
[2] Levene, P. A., "Hexosamines and Mucoproteins" (Longmans, Green, London, 1925).
[3] Wassermann, F., *J. Dent. Research*, **23**, 463 (1944).
[4] Meyer, K., and Smyth, E. M., *J. Biol. Chem.*, **119**, 507 (1937).
[5] Neuberg, C., and Cahill, W., *Rend. Accad. Lincei*, **22**, 149 (1935).
[6] Frisbie, H. E., Nuckolls, J., and Saunders, J. B. de C. M., *J. Amer. Coll. Dent.*, 243 (1944).

Microflora of the Rumen

QUIN[1], in his study of the rumen micro-organisms occurring in sheep fed exclusively on lucerne hay, noted the appearance of large numbers of ovoid, clear cellular organisms with an average size of $8\mu \times 4\mu$. He showed that rumen fluid rich in these organisms rapidly fermented glucose with the evolution of gas, and that under these conditions the organism stained mahogany brown on the addition of aqueous iodine solution. He did not state whether these organisms were motile, nor did he record any attempts at isolation by cultural methods. On the basis of their apparent reproduction by binary fission and their fermentative powers, Quin considered that these organisms were a type of false yeast, and accordingly named them '*Schizo-saccharomyces ovis*'.

Baker[2] and Elsden[3] have confirmed these observations, apparently acquiescing in the use of the term '*Schizo-saccharomyces ovis*'.

We have examined repeatedly the rumen contents of sheep, with permanent fistulæ, fed on a diet of meadow hay and mangolds, and have found that ovoid yeast-like forms are the overwhelmingly predominant organisms. In sheep fed on meadow hay only, these ovoid organisms are absent or in small numbers; but within three days of the addition of mangolds to the diet, they appear in great numbers.

In wet preparations under a coverslip, examined under the 1/6th eyepiece of the microscope soon after sampling, the majority of the ovoid forms are seen to be actively motile; but so far, no flagella have been detected either in stained or unstained preparations. Many of the forms appear to have an outer layer resembling an envelope or capsule, around the periphery of which there are a number of small granules, brightly refractile in unstained preparations and staining intensely with Giemsa.

As well as the ovoid forms, there are numerous crescent-shaped forms of approximately the same dimensions; in some individuals one long flagellum, in others two flagella, attached to the centre of the concave side can be detected.

If a relatively pure suspension of these ovoid and crescentic organisms is obtained by fractional centrifugation, mixed with 10 per cent glucose solution and incubated at 37° C., there is a rapid evolution of gas and reduction in *p*H. On microscopic examination, the organisms are found to be non-motile; on mixing with iodine solution, they stain deep mahogany brown, indicating the formation of glycogen.

Thus it would appear that we are dealing with the organisms termed '*Schizo-saccharomyces ovis*' by Quin, and, in disputing the use of this term, we wish to direct attention to a publication by Woodcock and Lapage[4], in which they describe observations on an oval and crescentic organism found in great numbers in the rumen contents of sheep and goats. They were able to demonstrate a single flagellum arising from the centre of the body in the crescent-shaped forms, but were unable to demonstrate a flagellum in the oval motile forms. After examination of authenticated strains of *Schizo-saccharomyces*, they stated that, in their opinion, these organisms were not related to that yeast. On the grounds that similar organisms had been described by Certes[5], they preferred to name them *Selenomastix ruminantium* (Certes). This protist is now referred to as *Selenomonas ruminantium* in the standard text-books on protozoology[6,7].

We have made numerous attempts to culture the ovoid and crescentic organisms using various media, incubated at temperatures ranging from 20° C. to 45° C., aerobically, anaerobically and in vessels containing additional carbon dioxide, but so far without success. At least four different types of yeasts have been recovered by one of us (C. A. McG.), but none of these appears to belong to the genus *Schizo-saccharomyces*. In view of the statement of Klein and Müller[8] that nectar yeasts play an important part in ruminant digestion, a detailed examination of the yeasts isolated is being pursued. It must be admitted, however, that yeasts appear to be present only in small numbers.

In conclusion, we suggest that the yeast-like organisms observed in the rumen contents are not *Schizo-saccharomycetes* but are the protists described by Certes[5] and by Woodcock and Lapage[4] and now named *Selenomonas ruminantium* (Certes).

C. A. McGaughey
K. C. Sellers

Institute of Animal Pathology,
Cambridge.
Feb. 20.

[1] Quin, J. I., *Onderstepoort J. Vet. Sci.*, **18**, 91 (1943).
[2] Baker, F., and Harris, S. T., *Nut. Abst. and Rev.*, **17**, 3 (1947).
[3] Elsden, S. R., *J. Exp. Biol.*, **22**, 51 (1945–46).
[4] Woodcock, H. M., and Lapage, G., *Quart. J. Micr. Sci.*, **59**, 431 (1913).
[5] Certes, *Bull. Soc. Zool. France*, **14**, 70 (1889), quoted by Woodcock and Lapage (ref. 4).
[6] Wenyon, C. M., "Protozoology" (Baillière, Tindall and Cox, London, 1926).
[7] Neveu-Lemaire, M., "Traité de Protozoologie" (Vigot Frères, Paris, 1943).
[8] Klein, W., and Müller, R., *Z. Tierzucht. Zuchtungsbiol.*, **48**, 277 (1941), quoted by Goetze, G., *Deutsch. Imkerfuhrer*, **9**, 125 (1941).

Chromosome Number of *Cardamine pratensis*

I NOTICE with interest Dr. Howard's records of chromosome counts of $2n = 56$ for several plants of *Cardamine pratensis* growing in damp places[1]. I have been working on British plants of this species for the last two years, with the help and guidance of Dr. K. B. Blackburn, and I have collected a very considerable amount of information on its chromosome number. The normal plant which grows in damp meadows has constantly the chromosome number $2n = 56$, judged from the evidence of seventy plants collected from eighteen vice-counties. Plants with semi-double flowers, first described by Dr. Wilfred Robinson[2] in 1925, have been found in fifteen localities in wet places, chiefly in the north of England. They have the same chromosome number $2n = 56$. Plants with $2n = 30$ chromosomes seem to be characteristically from the south of England. Those examined include five normal plants and seven completely sterile double-flowered plants. No other chromosome numbers than these have so far been encountered.

The ecological difference found by Lövkvist holds good in most of the cases recorded; for example, Prof. R. D'O. Good, who kindly provided material from Dorset, noted particularly that the large plant, now found to have the low chromosome number, occurred in quantity on the damp roadside banks characteristic of Marshwood Vale, whereas the smaller darker-leaved one ($2n = 56$) grew in wet meadows.

As I am now trying to map the distribution of the different forms of *Cardamine pratensis*, I should be very grateful for living plants particularly from Scotland, the south and east coasts of England and Ireland.

F. Hussein

Department of Botany,
King's College,
Newcastle-upon-Tyne 1.
Feb. 25.

[1] *Nature*, **161**, 277 (1948).
[2] *Mem. and Proc. Manchester Lit. and Phil. Soc.*, **69** (Feb. 1925).

Distribution Patterns in European Basidiomycetes with Reference to Some British Species

NINETEENTH-CENTURY mycologists, impressed by the wide distribution of agarics and polypores, were inclined to regard them as truly cosmopolitan. Subsequent experience has modified this view by indicating that, at least as regards Basidiomycetes, the flora of tropical regions does not usually consist of the same species as that of the north temperate zone. It is also often doubtful whether a specific epithet has been applied to the same species in North America as in Europe. Even within a rather small area such as Europe, gradually accumulating distributional data have shown that not all the higher fungi occur in all parts of the Continent. Thus, in the comparatively rich British Basidiomycete flora, it is possible to distinguish components characteristic of different Continental regions. For the present it may be sufficient to recognize a northern European, southern European and Oceanic type of distribution; but when the European fungus flora has been adequately studied from this point of view, it will probably be possible not only to define these with greater precision but also to recognize other, smaller, mycological provinces.

A typical example of the northern European group is *Exidia repanda* Fr. The European distribution of this species, as quoted by Neuhoff[1], is shown in Fig. 1. Here the individual crosses in the Scandinavian peninsula do not represent separate collections but cover the reported range of the species. This very distinct and easily recognizable fungus was collected for the first time in Britain on birch trees at Shieldaig, Wester Ross, in June 1947. It seems unlikely that such a conspicuous species can have escaped observation in England; if it does occur there at all it must be rare or sporadic. Fungi of the northern European

Fig. 1. ×, *Exidia repanda*; o, *Polyporus torulosus*

Fig. 2. ×, *Pleurotus palmatus*; o, *Ditangium cerasi*

group are likely to have a circumpolar range, and Neuhoff suggests that *E. repanda* is identical with species described from North-East Asia and from North America.

Fig. 2 shows the European distribution of a typical Oceanic species, *Pleurotus palmatus* (Bull. ex Fr.) Quél., according to Pilat[2], who rejects as erroneous all German and central European records of this fungus. If it occurs at all in central Europe it must do so very rarely, for when Pilat published his monograph of *Pleurotus* he had never seen a fresh specimen of it. Within the British Isles the species appears to be prevalent only in the south of England. There are some twenty-three published collections of it from south of the Humber, only four from England north of the Humber and none from Scotland. *P. palmatus* was not known to Lange in Denmark and the Swedish occurrences appear to constitute a somewhat anomalous extension of its range. Dr. Jørstad kindly informs me that it has not yet been found in Norway.

A species with a conspicuously southern European distribution is *Polyporus torulosus* Pers., identified by Miss Wakefield for the first time from Britain in a collection made by me on *Arbutus unedo*, Killarney, in August 1946. Its known range in Europe is plotted in Fig. 1 from the data of Pilat[3]. Except for a single record from the neighbourhood of Riga, perhaps in need of confirmation, the species appears to be unknown in Europe north of about lat. 52° N. Details are unfortunately lacking regarding its range in France; Bourdot and Galzin[4] merely state that it is common in that country. Its extra-European distribution is said to include China, Japan and the southern United States of America.

There is also a considerable group of species with a Continental type of distribution which do not reach the British Isles. Typical of these is *Ditangium cerasi* (Tul.) Cost. and Duf., the range of which is plotted in Fig. 2 for comparison with that of Oceanic species.

It is as yet impossible to estimate the relative proportions of these and other geographical components in the British fungus flora. Not only is there too little information available regarding the distribution of the larger fungi throughout Europe but also, to a greater extent than in any other group of plants, one can usually draw no reliable inferences from such local lists of species as have been published. Too often, especially in Agaricaceæ, species have been interpreted by different authors in widely differing senses. Thus, unless a full description is given of the individual collection cited, or it is definitely stated to conform to the conception of the species by some well-known authority, the published names have little value. This difficulty in standardizing the interpretation of species makes it especially desirable that British and Continental mycologists should have ample opportunity of meeting and studying disputed species together in the field. The attendance of many prominent European mycologists at the British Mycological Society's semicentenary celebrations in 1946 was a welcome step, made possible by the British Council; but much more frequent contact is required, and especially the provision of facilities for British mycologists to study the European fungus flora in the field.

R. W. G. Dennis

Royal Botanic Gardens,
Kew.
March 3.

[1] Neuhoff, W., "Die Gallertpilze" (Leipzig, 1935).
[2] Pilat, A., "Pleurotus" (Praha, 1935).
[3] Pilat, A., "Polyporaceæ" (Praha, 1936–42).
[4] Bourdot, H., and Galzin, A., "Hymenomycetes de France" (Paris, 1927).

Puffinosis, a Virus Epizootic of the Manx Shearwater (*Puffinus p. puffinus*)

In the years 1946 and 1947, epizootics have been observed among the manx shearwaters on the island of Skomer off the Pembrokeshire coast[1]. The birds affected have been juveniles nearly ready to leave the island. The disease is characterized by the occurrence of large blisters on the web, either plantar or dorsal surfaces. In 1946 severe conjunctivitis was also a notable feature, but was rare in 1947. Some birds show spasm of the legs shortly before death. It is estimated that at least 90 per cent of the birds with clinical signs die of the disease.

At post-mortem some birds show no definite lesions other than those in the web. Others have round patches of consolidation in the lungs. Histologically, the web around the blisters shows great inflammatory change, and acidophil cytoplasmic inclusions may be seen in the cells of the epidermis. Cultures of the blister fluid yield either a mixed culture or a pure culture of *Staphylococcus aureus*.

Bacteriologically sterile blood from a shearwater moribund from the disease was inoculated on to the chorio-allantoic membrane of embryonated hen's eggs of varying ages, and lesions suggesting a virus infection were found. Sections of these membranes showed ectodermal proliferation, some mesodermal reaction and homogeneous acidophil inclusions in the cytoplasm of the ectodermal cells. Passage in the embryonated hen's egg did not readily yield easily

recognizable macroscopic lesions, although microscopic lesions containing typical inclusions were always present. From the thirteenth passage onwards, minute pocks 0·05–0·2 mm. in diameter have been regularly observed 72 hours after inoculation; but because of their minute size, titration of the virus by pock counting methods is impracticable.

When ducklings one to two weeks old were inoculated with either original shearwater or egg-passage material by light scarification of the dorsum of the web of one foot, a disease closely resembling that in the shearwater developed after about three days. Blisters occurred on the inoculated webs, and many of the birds which died also showed lung lesions similar to those in the shearwater. Such lesions have not been found in controls.

Attempts have been made to estimate the approximate size of the virus particle by filtration through 'Gradocol' membranes. When tested either in eggs or in ducklings, it has been repeatedly shown that small amounts of virus pass through membranes having an average pore diameter of 48 mμ. Membranes of smaller pore diameter have not been available.

Material from the twentieth egg passage was found to give typical lesions in ducklings when diluted 10^{-7} but not at 10^{-8}. A neutralization experiment was carried out in ducklings using diluted material from this egg passage with serum from a shearwater which died in the acute stage of the disease, and a pool of serum from two which had survived exposure to the disease. With the acute serum, one duckling out of five showed infection when inoculated with material diluted to 10^{-7} and four out of five when diluted 10^{-6}. With the survivor serum no infections occurred at either dilution. The acute serum did not fix complement in 1 hour at 37° C. in the presence of antigens made either from the organs of infected ducklings or from infected chorio-allantoic membranes, while the survivor serum fixed two minimal hæmolytic doses of complement to a dilution of 1 : 10 in the presence of both antigens.

Virus was inoculated by scarification into the plucked breasts of four adult pigeons. Large blisters developed on the sixth day on two of these birds. The virus was recovered from the blister fluid. Lesions have not been produced by primary inoculation of the virus either into the comb of a cockerel or into the plucked breasts of four-week-old chicks.

Attempts have been made to pass the virus to the rodents in common use in the laboratory. The original material from shearwaters was inoculated into mice by various routes without any definite lesions being obtained. Inoculation of twentieth egg passage material into young guinea pigs, rabbits and rats or into adult mice by scarification into the pads, or in young guinea pigs and rabbits by inoculation intradermally into the dorsum of the tongue, have not yielded any definite evidence of infection.

There is some evidence that juvenile herring gulls (*Larus argentatus*) have been infected in Nature, and it is highly probable that investigations might show a wider distribution of the disease. We suggest that the name 'puffinosis' is suitable for this epizootic disease of *Puffinus puffinus puffinus*.

J. A. R. Miles
M. G. P. Stoker

Department of Pathology,
University of Cambridge.
May 11.

[1] Surrey-Dane, D. S., *Ibis*, **90**, 340 (1948); *J. Anim. Ecol.* (in the press).

Theory of Superconductivity

The present note is a continuation of another one submitted recently to *Nature* [see *Nature*, June 19, p. 968]. The calculations reported here are mainly due to the junior author.

The explanation given for superconductivity consisted in showing that in certain metals, characterized by a certain ratio of the lattice constant in the reciprocal space to the radius of the Fermi surface, the lowest energy state corresponds to a distribution with spontaneous currents. We obtained an expression of the correct order of magnitude for the transition temperature. Here we shall show that these spontaneous currents arrange themselves in a magnetic field in such a way that, for weak fields, London's equations between current and field hold, while for strong fields deviations are to be expected.

An investigation of the energy-levels of the electronic motion shows that they are little influenced by an external magnetic field. This effect can be rightly ignored, and the magnetic energy simply added to that of the electrons. Then the total free energy is (compare the previous note)

$$F = \int \left\{ U_0 + \frac{1}{2}\omega^2 \frac{h^2 n^2}{4\pi m}\left(\frac{\pi}{3n_0}\right)^{1/3} - \frac{\omega}{\omega_0}\frac{2\pi^2 m}{3h^2}\left(\frac{3n_0}{\pi}\right)^{1/3}(kT)^2 + \frac{1}{8\pi}H^2 \right\} d\tau. \quad (1)$$

Now the spontaneous current is proportional to the number of the occupied corners of the Brillouin zone $\omega_0 - \omega$, so that the magnitude of the spontaneous current density is

$$j = \frac{nev_s}{c}(\omega_0 - \omega), \quad (2)$$

where $v_s = \frac{hn^{1/3}}{m^*} \sim 3{\cdot}3 \times 10^7$ cm. sec.$^{-1}$ is the velocity of the superconducting electrons. Neglecting ordinary (Ohm) currents which are short-circuited by the superconductive regions, one has the relation

$$4\pi \mathbf{j} = \text{curl } \mathbf{H}. \quad (3)$$

Introducing (2) and (3) one obtains,

$$F = F_0 + \frac{1}{8\pi}\int \left\{ \mathbf{H}^2 + \beta^2 (\text{curl } \mathbf{H})^2 - \gamma \,|\, \text{curl } \mathbf{H} \,| \right\} d\tau, \quad (4)$$

with the abbreviations

$$\left.\begin{aligned} \beta^2 &= \frac{h^2c^2}{(4\pi)^2 m e^2 v_s^2}\left(\frac{\pi}{3n_0}\right)^{1/3}, \\ \gamma &= \frac{hcn\omega_0}{2\pi m e v_s}\left(\frac{\pi}{3n_0}\right)^{1/3}\left(1 - \frac{T^2}{T_0^2}\right) \end{aligned}\right\} \quad (5)$$

The field distribution is obtained by minimizing the expression (4) with respect to **H**, taking into account the continuity of **H** on the boundary. We split $\mathbf{j} = \frac{1}{4\pi}\text{curl } \mathbf{H}$ into two parts:

$$\mathbf{j} = \mathbf{j}_0 + \mathbf{j}', \text{ where } (\mathbf{j}_0)_{\text{av.}} = 0.$$

If $|\,\mathbf{j}_0\,| > |\,\mathbf{j}'\,|$, which happens for small fields, one gets London's equation for the stationary case:

$$\Delta \mathbf{H} = \lambda \mathbf{H}, \quad (6)$$

with $\lambda = \frac{3}{\beta^2}$, $\frac{1}{\sqrt{\lambda}} = \frac{\beta}{\sqrt{3}} \sim 3 \times 10^{-6}$ cm.

On the other hand, if the external field is large, then London's equation breaks down and has to be replaced by the following one:

$$\Delta \mathbf{A}\left(1+\frac{\gamma\,|\,\mathbf{j}_0{}^2\,|}{6\beta^2\,|\,\Delta\mathbf{A}\,|^2}-\frac{\gamma}{2\beta^2\,|\,\Delta\mathbf{A}\,|}\right)=\frac{1}{\beta^2}\,\mathbf{A}, \quad (7)$$

where **A** is the vector potential.

Even for large fields the region where equation (7) holds is only a thin boundary layer, the thickness of which (the penetration depth δ) is obtained by postulating that the function **H** is continuous across the surface between the boundary layer and the interior where the London equation (6) holds. One obtains for very strong external fields H_0 (for which no experimental results are available)

$$\delta = 0{\cdot}47\,\beta\sqrt{\frac{H_0}{H_f\,(1-T^2/T_0{}^2)}}, \quad (8)$$

where H_f is a constant.

The threshold magnetic field is obtained by equating the free energy of the normal and the superconducting states. The first is $F_0+\frac{1}{8\pi}\int \mathbf{H}_0{}^2 d\tau$, where $\mathbf{H}_0$ is the external magnetic field; and the second is the expression (4), where **H** is the superconductive field. The calculation leads to the formula

$$H_c = H_m\,(1-T^2/T_0{}^2), \quad (9)$$

with

$$H_m = T_0{}^2\,\frac{8\pi^4 m k^2}{3h^2}\left(\frac{3n_0}{\pi}\right)^{1/3}. \quad (10)$$

This agrees with the experimental results, not only with respect to the dependence on the temperature T, but also to the order of magnitude.

MAX BORN
KAI CHIA CHENG

Department of Mathematical Physics,
University of Edinburgh.
May 26.

Mechanism of the Emission Spectrum of Active Nitrogen

IN a recent paper Mitra[1] has attempted to explain the remarkable features of the nitrogen afterglow, which have also been studied again by Lord Rayleigh[2] on the assumption of an emission that would follow the recombination between the ions $N_2{}^+$ with electrons. It seems difficult to explain the previous observations and those described here by this simple hypothesis.

We have shown in previous work[3] the existence of complex afterglow arising from the overlapping of several mechanisms. Besides the long duration of the yellow afterglow (α-bands) we observe a short one which consists of the first positive system without definite selectivity, the second positive and the first negative systems. The distribution of intensity of this afterglow changes with the pressure and the action of the walls.

Working with the phosphoroscope of P. Lejay[4] we have also investigated qualitatively the effect of temperature on this afterglow. A comparison was made between the emissions at the surrounding temperature and when liquid air was poured in the Dewar vessel in which the discharge tube was immersed. Under these conditions we observed the following modifications in the composition of the afterglow.

As in the case of the yellow emission, a rise of the intensity of the whole of the spectrum at low temperature is observed, but it is not of the same weight for all systems.

First positive system. At laboratory temperature, there is a strong emission without a striking selection; its relative intensity rises when the pressure decreases and the temperature increases. At low temperature, the distribution of intensity in the sequences changes because of the increase of the bands at $v' = 6$ and 10 (α-bands).

Second positive and first negative systems. At a pressure of 10^{-2} mm. to 10^{-1} mm. mercury, their intensity increases about three times at 10^{-4} sec. after breaking up the discharge. The bands with $C^3\Pi$, $v' = 3{\cdot}4$ increase in relative intensity in afterglow.

Goldstein bands. At low temperature, this system increases in relative intensity. When the discharge is cut off, it suffers less variation than the neighbouring bands of the second positive system (Fig. 1). The emission of this system follows a recombination between two atoms of nitrogen (^2D) in a similar way to the bands with $C(v' = 3{\cdot}4)$ of the second positive system. The similar behaviour of these bands belonging to different systems confirms our interpretation.

Green system. The three strongest bands $\lambda\lambda$ 5079 (0·0), 5308 (0·1), and 5570 (0·2) continue in the afterglow with greater strength at low temperature (Fig. 2).

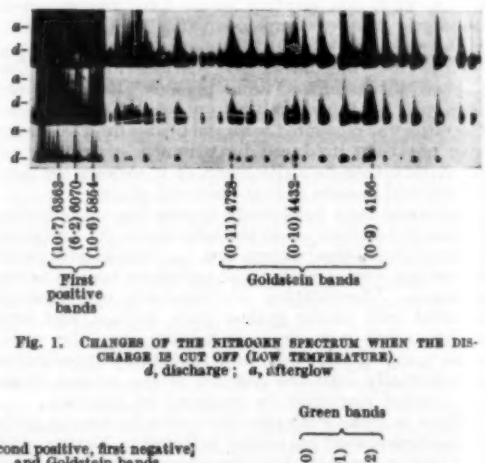


Fig. 1. CHANGES OF THE NITROGEN SPECTRUM WHEN THE DISCHARGE IS CUT OFF (LOW TEMPERATURE). *d*, discharge; *a*, afterglow

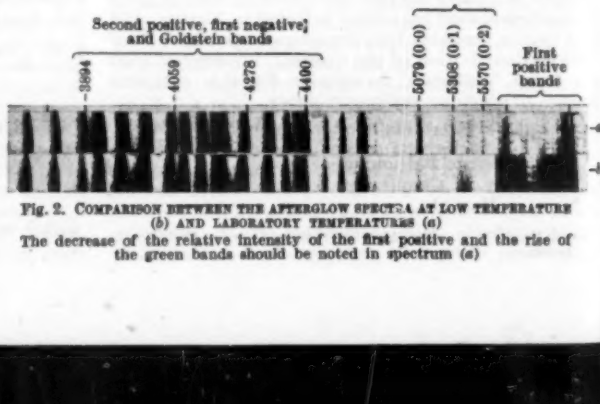


Fig. 2. COMPARISON BETWEEN THE AFTERGLOW SPECTRA AT LOW TEMPERATURE (*b*) AND LABORATORY TEMPERATURES (*a*)
The decrease of the relative intensity of the first positive and the rise of the green bands should be noted in spectrum (*a*)

Our results show that the hypothesis of Mitra is unable to explain all the features of active nitrogen. The strong emission of the first negative system must result from a recombination of the doubly ionized ions N_2^{++} and electrons. To account for the increase of the Goldstein and selected bands of the second positive system, we must assume an atomic recombination. Likewise the selective emission of the first positive system is made clear by the Carion and Kaplan mechanism in which one molecule of nitrogen ($A^3\Sigma$, $v = 0$) is excited by an atom of nitrogen (^2D) or (^2P). It is possible also that the emission of the bands at $B(v' = 6)$ results from the interaction with the $^1\Pi$-level. For example, it would not seem possible to admit that the emissions of the first and second positive systems follow the same mechanism of capture of electrons:

$$(N_2^+ + e \rightarrow C^3\Pi \rightarrow B^3\Pi + h\nu \text{ (second positive)};$$
$$B^3\Pi \rightarrow A^3\Sigma + h\nu \text{ (first positive)};$$

since it would not account for the great variations in their relative intensity with the experimental conditions.

The remarkable features of active nitrogen seem rather to result from the fact that this diatomic molecule is like an inert gas that permits many reactions between atoms, ions and electrons.

L. Herman
R. Herman

Laboratoire des Recherches Physiques,
Faculté des Sciences de Paris.
Dec. 29.

[1] Mitra, S. K., "Active Nitrogen: a New Theory" (Indian Association for the Cultivation of Science, Calcutta, 1945).
[2] Lord Rayleigh, *Proc. Roy. Soc.*, A, **176**, 1 (1940); A, **180**, 123 (1942).
[3] Herman, R., *C.R. Acad. Sci.*, **220**, 593, 878 (1945).
[4] Lejay, P., *C.R. Acad. Sci.*, **216**, 536 (1944).

Reported Radioactivity of Osmium

For some time it has been known that two isobars which differ by unity in atomic number cannot both be stable, except for a possible influence of the neutrino if its mass has a positive value at rest. A search for radioactivity among the existing pairs of isobars led to the announcement[1] of K-electron capture in osmium (Os^{187}) with a half-life of about 3×10^9 years. However, a recent paper on beta-stability[2] contains the following remark: "The reported radioactivity of Os^{187} has recently been questioned, with indications that Re^{187} instead is radioactive"[3]. It seems worth pointing out that some time ago another argument had thrown strong doubts on the view that osmium is radioactive.

This conclusion rests on data, contained in a paper by Noddack and Noddack[4], which gives the results of rhenium determinations in a number of minerals. These authors find the rhenium content of osmiridium from New South Wales to be about 10^{-5} per cent and of a sample from the Urals about 10^{-4} per cent. From what is known about the rocks from which the platinum ores originate, we may take 2×10^9 years as a fair estimate of the age of most of the osmiridium samples investigated by Noddack. Osmiridium usually contains between 30 and 50 per cent osmium, and 1·64 per cent of the latter is Os^{187}. Therefore, if the rate of radioactive decay quoted above were correct, osmiridium should contain about $\frac{1}{4}$ per cent rhenium. Although the figures for the rhenium content and for the age of osmiridium are admittedly inaccurate, the discrepancy of at least something like 10^4 is sufficiently large to prove that, if K-electron capture occurs in osmium, the half-life must be several orders of magnitude longer than that given by Lougher and Rowlands.

A. H. W. Aten, jun.
Institute for Nuclear Research,
Amsterdam.
March 8.

[1] Lougher, E. T., and Rowlands, S., *Nature*, **153**, 374 (1944).
[2] Kohnan, T. P., *Phys. Rev.*, **73**, 16 (1948).
[3] Libby, W. F., and Naldrett, S. N. (private communication to Kohnan).
[4] Noddack, I., and Noddack, W., *Z. Physik. Chem.*, **154**, 207 (1931).

The Metallic State

In the development of the resonating-valence-bond theory of metals, it has become evident that the characteristic structural feature of metals is the possession by each atom or each of many atoms in the metallic phase of an extra orbital (the 'metallic orbital'), in addition to the orbitals normally occupied by electrons. This metallic orbital permits the unsynchronized resonance of electron-pair bonds from one interatomic position to another by the jump of one electron from an atom to an adjacent atom, leading to great stabilization of the metal by resonance energy, and to the characteristic metallic properties.

For example, in lithium each atom has one valence electron, permitting the formation of an electron-pair bond for each pair of atoms. These bonds resonate among alternative positions, mainly the eight positions between each atom and its eight nearest ligands. If each atom were required to remain neutral, by retaining its valence electron, the stabilization through the permitted synchronized bond resonance,

$$\left\{\begin{matrix} \text{Li—Li} & \text{Li} & \text{Li} \\ & | & | \\ \text{Li—Li} & \text{Li} & \text{Li} \end{matrix}\right\},$$

analogous to that in the benzene molecule, would be relatively small. Much greater stabilization results from unsynchronized resonance such as

$$\left\{\begin{matrix} \text{Li—Li} & \text{Li}^- \text{—Li} \\ & | \\ \text{Li—Li} & \text{Li} \quad \text{Li}^+ \end{matrix}\right\},$$

involving the use of an additional orbital on the atom receiving an extra bond. The electronic conductivity and other characteristic properties of metals may be described in terms of the transfer of the positive and negative charges from atom to atom accompanying the resonance of the valence bonds.

The resonance energy resulting from use of the metallic orbital in metals outweighs the energy of repulsion of adjacent non-bonded atoms and permits the co-ordination number of atoms to be greater than the number of valence electrons or bond orbitals. Thus tin, with 14 outer electrons and 9 stable orbitals (five $4d$, one $5s$, and three $5p$, or hybrids of them), may place electron pairs in five orbitals and single electrons in the other four; this quadrivalent tin, with no extra orbital, forms the essentially non-metallic phase grey tin, with the diamond structure (co-ordination number 4, non-resonating single bonds). However, a metallic orbital can be made available by placing six unshared electron pairs in six orbitals, and single electrons in two orbitals. This bivalent

tin is present in the metallic phase, ordinary white tin, in which each atom has co-ordination number 6.

It is not necessary that every atom in a metallic system have a metallic orbital. The four bonds of each quadrivalent tin atom in the compound AuSn[1] are able to resonate among the six positions to the six adjacent gold atoms by pivoting around the tin atom, making use of the extra orbitals of the gold atoms. About one quarter of the atoms in white tin are quadrivalent, the average valence thus being about $2\frac{1}{4}$, and the average number of metallic orbitals per atom about $\frac{3}{4}$. These considerations thus explain the previously puzzling non-integral number 0·78 of extra orbitals per atom and the non-integral valencies, such as 2·44 for tin, which were found ten years ago by the analysis of magnetic data[2].

The problem of the choice between alternative structures for a metal or intermetallic compound that satisfy the metallic valencies of the atoms equally well can be discussed by a treatment resembling the customary Brillouin-zone theory, but involving the resonance of electron-pair bonds throughout the crystal, rather than of single electrons. We may, as an approximation, formulate the wave function for a crystal as an electron-antisymmetrized combination of product functions constructed of two-electron functions, each of which represents an electron-pair bond resonating among the interatomic positions in the crystal. These two-electron functions may be set up as a combination of bond functions multiplied by suitable Bloch factors; the resonance energy then leads to a splitting of energy levels qualitatively similar to that given by the usual one-electron molecular orbital theory, and with the same electron numbers for the Brillouin polyhedra. The agreement between the newly proposed metallic valencies of the transition metals and the electron numbers filling important Brillouin polyhedra for some filled-zone substances (the γ-alloys, α-manganese, β-manganese) has been pointed out in a recent paper[3].

Another way of discussing the choice between alternative structures is based upon the special stability associated with the resonance of valence bonds among interatomic positions when the ratio of bonds to positions is that of small integers. This effect most strongly stabilizes bonds with bond number $\frac{1}{2}$ (half-bonds), corresponding to resonance of one bond between two positions, followed by bonds with bond numbers $\frac{1}{3}$, $\frac{2}{3}$, $\frac{1}{4}$, $\frac{3}{4}$, etc. It is thus possible to understand the stability of the unusual metal structures shown by zinc, cadmium, mercury, white tin, gallium, β-tungsten, β-uranium and a few other metals, as well as that of the structures of many intermetallic compounds. For example, if zinc, with metallic valency 4·5, had a normal close-packed structure, each of the twelve bonds formed by a zinc atom would be a $\frac{3}{4}$-bond. By increasing the axial ratio of its crystal from the value 1·633 (for hexagonal close packing) to 1·861, each zinc atom is able to form six half-bonds (of length 2·660 A.) and six quarter-bonds (2·907 A.), and the crystal gains the extra stability accompanying these simpler bond numbers. Similarly, the selection of the body-centred structure by the fifth-group elements can be understood: this structure, in which each atom uses its valency 5 to form half-bonds with its nearest eight ligands and $\frac{1}{4}$-bonds with the six more distant ones, is in consequence of the simple bond numbers more stable than a close-packed structure, involving twelve $\frac{5}{12}$-bonds.

This resonating-valence-bond theory of metals will be discussed in detail elsewhere.

LINUS PAULING

At Balliol College,
Oxford.
May 6.

[1] Pauling, L., *J. Amer. Chem. Soc.*, **69**, 542 (1947).
[2] Pauling, L., *Phys. Rev.*, **54**, 899 (1938).
[3] Pauling, L., and Ewing, F. J., *Rev. Mod. Phys.*, **20**, 112 (1948).

Adsorption on to Ionogenic Surfaces

Michaelis and Ehrenreich[1] were the first to suggest that the adsorption of large ions such as the organic dyes, on ionogenic surfaces, takes place by two distinct mechanisms operating simultaneously: one of an electrochemical nature, and in addition to this a 'normal' physical adsorption. Later, Freundlich and Poser[2] stated explicitly that the adsorption of large positive ions on clays could be explained qualitatively by the combined effects of an irreversible ion-exchange adsorption and a reversible physical adsorption, and this idea was further elaborated by Michaelis and Rona[3]. It is interesting for the historian of science that this simple idea was afterwards forgotten, but was 'rediscovered' on several occasions prior to our work. The idea of simultaneous adsorption by two different mechanisms is not mentioned by Swan and Urquhart[4] in their comprehensive review on adsorption, or in text-books. Even Freundlich himself in his "Kapillarchemie" (1930) seems to have lost sight of the implications and usefulness of the idea, but it was formulated in different ways by Stadnikoff[5], Fogle and Olin[6], Hendricks[7] and Grim *et al.*[8].

We have arrived independently at the conclusion that the adsorption of basic dyes on clays is governed by two essentially different mechanisms. It is known that when basic dyes are adsorbed on clays a certain fraction of the adsorbed amount is held irreversibly and displaces an approximately equivalent quantity of cations from the clay[7,8,9]. If this exchange adsorption is absolutely irreversible, the amount of dye held in this way will be directly proportional to the quantity of clay present and independent of the dye concentration in the solution. If we bring increasing quantities of dye into contact with a given mass of clay, at first every molecule of dye added to the system will be adsorbed and held irreversibly, and this will go on until the base-exchange capacity of the clay is saturated. As soon as there is an excess of dye present, it will be physically adsorbed on to the exchange-saturated clay. The quantity of dye thus held will be a function of the concentration of dye remaining in solution after the portion held by ionic exchange has been taken out. From these considerations it follows that, in general, the number of milli-equivalents x of dye taken out of v ml. of a solution of initial concentration c_0 m.equiv./ml. by m gm. of clay will be a function of m, c_0 and v. This treatment is a first approximation: it neglects the possibility that, on account of the accessibility of exchange sites to the large dye molecules, the exchange capacity for dyes may be less than the general base-exchange capacity; it also neglects time effects and possible transitions between the two states of adsorption.

This theory of adsorption can be formulated quantitatively thus. Let x_1 and x_2 be the 'exchange' and 'physical' contributions to the total adsorption.

Then $x = x_1 + x_2$,

but $x_1 = k_1 m$, where $k_1 =$ constant,

so that the quantity of dye remaining in solution after the exchange adsorption is given by $(vc_0 - x_1)$. This will set up a reversible equilibrium which may be described, for example, by a Freundlich isotherm with constants k_2 and n. If c is the final concentration of dye in the solution,

$$x_2 = m.k_2.c^n.$$

$$\text{Therefore} \quad x = m(k_1 + k_2 c^n),$$

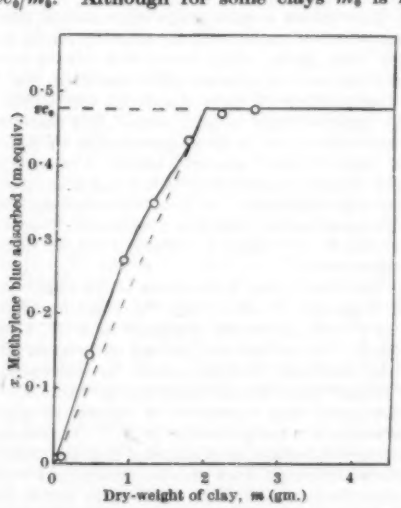
$$\text{or since} \quad c = c_0 - x/v$$

$$x/m = k_1 + k_2(c_0 - x/v)^n.$$

This equation was found empirically by Gurwitsch[10] but was misinterpreted and its significance overlooked. It defines a surface in the $(x - m - c_0)$ diagram which will be characteristic for each system. At constant c_0 and v we have:

$$\frac{dx}{dm} = \frac{k_1 + k_2 c^n}{1 + \frac{mn}{v} k_2 c^{n-1}}.$$

As $m \to 0$ and thus $c \to c_0$, $dx/dm \to k_1 + k_2 c_0^n$. As $c \to 0$ with increasing m, $dx/dm \to k_1$. The shape of this (x,m) curve is represented by the full line in the diagram. Experiments by one of us (P. H. P.) with various clays, in which x was measured for methylene blue as a function of m at constant c_0 and v, gave results such as those for floridin shown in the graph. The agreement with the shape of the theoretical curve is reasonable, except where $x \to vc_0$. This discrepancy is probably due to the approximations used in the theory. It is smaller for Wyoming bentonite, for example, for which k_1 is greater than k_2. For all values of m greater than a certain critical value m_0, $x = \text{const.} = vc_0$; m_0 is the weight of clay which is exactly 'exchange-saturated' by vc_0 m.equiv. of dye, that is, the exchange adsorptive capacity of the clay is given by vc_0/m_0. Although for some clays m_0 is rather indefinite, the value of $vc_0/m_0 = k_1$ agrees well with the base exchange capacity of the clays, as is to be expected. k_1 can be found from measurements such as those represented in the graph. Knowing k_1, then k_2 and n can be found from the plot of log $(x/m - k_1)$ against log c. Alternatively, k_1 is given by the intercept of the $(x/m, c)$ plot on the axis of x. (We are indebted to Dr. M. Szwarc for pointing this out.)



ADSORPTION OF METHYLENE BLUE ON FLORIDIN CLAY. $v = 50$ ml. $c_0 = 0{\cdot}357$ PER CENT

Since the derivation of the theory outlined above is very general, it should be applicable wherever adsorption takes place by a combination of reversible and irreversible mechanisms; for example, dyeing, staining, adsorption on humus, peat, polymeric acids, ion-exchange resins, etc.

The subject will be treated more fully in a forthcoming publication.

P. H. PLESCH

Chemistry Department,
University, Manchester.

R. H. S. ROBERTSON

1 Botanic Crescent,
Glasgow, N.W.
March 4.

[1] Michaelis and Ehrenreich, *Biochem. Z.*, **10**, 283 (1908).
[2] Freundlich and Poser, *Kolloid Chem. Beihefte*, **6**, 297 (1914).
[3] (*a*) Michaelis, L., and Rona, P., *Biochem. Z.*, **97**, 57 (1919); (*b*) **102**, 268 (1920).
[4] Swan and Urquhart, *J. Phys. Chem.*, **31**, 251 (1927).
[5] Stadnikoff, *Kolloid Z.*, **31**, 19 (1922).
[6] Fogle and Olin, *Indust. Eng. Chem.*, **25**, 1069 (1933).
[7] Hendricks, S. B., *J. Phys. Chem.*, **45**, 65 (1941).
[8] Grim, R. E., Allaway, W. H., and Cuthbert, F. L., *J. Amer. Ceramic Soc.*, **30**, 137 (1947).
[9] For example, Seidell, A., *J. Amer. Chem. Soc.*, **40**, 312 (1918).
[10] Gurwitsch, *Z. physik. Chem.*, **87**, 323 (1914).

A Simple Moving-Boundary Apparatus

Baxter and Gold[1] in their letter under the above title appear to be unaware of a paper by Drew and Hartley[2] describing the similar use of a single three-way tap arrangement for bringing together the leading and indicator solutions in the moving-boundary method of transport number measurement. As the apparatus described by Drew and Hartley was employed in the development of a new method for the measurement of transport numbers and might be overlooked, Baxter and Gold may be justified in directing attention to this simple experimental arrangement. I do not, however, share their views regarding the superiority of the tap arrangement over certain other conventional apparatus. I have had some experience of various types of moving-boundary apparatus, including one similar to that described by Baxter and Gold. I found that the air-lock device described by Hartley and Donaldson[3] not only possessed the qualities claimed by Baxter and Gold for their tap arrangement but also was superior in other respects. Thus the air-lock device allows of greater ease of manipulation when the apparatus is supported in a thermostat, and its avoidance of a lubricant is a desirable feature in studies with non-aqueous media. Moreover, its inexpensiveness relative to a good-grade tap, its simplicity together with its ease of construction, render the device very appropriate for use in undergraduate practical courses.

R. H. DAVIES

Department of Chemistry,
University College,
Swansea.

[1] Baxter and Gold, *Nature*, **161**, 403 (1948).
[2] Drew and Hartley, *Trans. Farad. Soc.*, **30**, 655 (1934).
[3] Hartley and Donaldson, *Trans. Farad. Soc.*, **33**, 458 (1937).

X-RADIATION FROM A 20-MeV. BETATRON

By W. BOSLEY, Dr. J. D. CRAGGS
AND
W. F. NASH
High Voltage Laboratory, Metropolitan-Vickers Electrical Co., Ltd., Manchester
AND
R. M. PAYNE
A.E.I. Research Laboratory, Aldermaston, Berks

IT is of interest and importance to know the energy distribution of the radiation emitted from betatrons and synchrotrons, since such knowledge is necessary in cases where cross-sections of nuclear reactions are to be determined[1], and in estimating the clinical effect of such radiation.

For some months we have been investigating the spectrum of the radiation from the 20-MeV. betatron (Kerst type) built in this Laboratory, using two methods, namely, the study of (*a*) electron-positron pairs produced in a thin lead sheet in a Wilson chamber, and (*b*) the protons liberated in the photo-disintegration of deuterons using either a scattering chamber with a heavy wax target or deuterium-loaded plates (Ilford *C*2 Emulsion). Lasich and Riddiford[2] have investigated independently the spectrum of the X-rays from a 2·8-MeV. betatron using Compton recoil electrons.

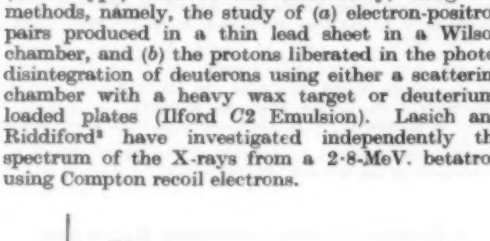


Fig. 1 (*a*)

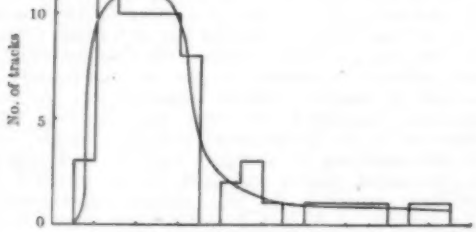


Fig. 1 (*b*)

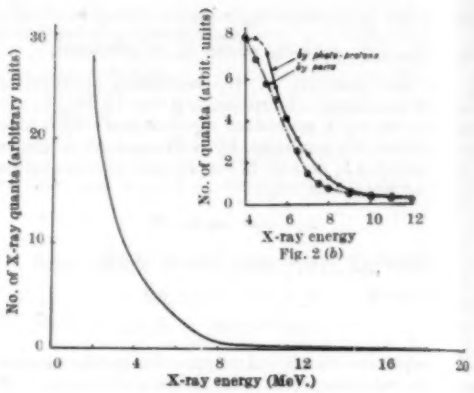


Fig. 2 (*b*)

Fig. 2 (*a*)

Method (*a*) has been used for measuring gamma-ray spectra for many years[3,4], and involves the measurement of the energy (ε) of a large number (N) of pairs (after precautions have been taken to ensure that they are produced by primary photons from the incident beam only). The plot of $N(\varepsilon)d\varepsilon$ against ε, corrected for variations in pair-production cross-section with energy[4], then gives the spectrum. Since this work was started, a modification of the method has been published by Baldwin and Klaiber[4].

Method (*b*) uses the nuclear reaction :

$$D_1^2 + \gamma \rightarrow H_1^1 + n_0^1$$

discovered by Chadwick and Goldhaber[7], who deduced from it the binding energy of the deuteron. Powell *et al.*[8] have suggested that the reaction could be used to measure gamma-ray energies, and more recently a group in the Cavendish Laboratory has used deuterium-loaded Ilford plates to investigate (at about 6 MeV.) the angular distribution with reference to the incident beam of the photo-protons[9] ; and their note should be read for an appreciation of the theoretical importance of the reaction.

Fig. 1(*a*) shows a histogram constructed from 65 electron-positron pairs, and the smooth curve drawn through this gave, when corrected for the cross-section variation, the distribution shown in Fig. 2(*a*). Since the number of pairs measured was small, this may be regarded only as provisional, but there would certainly seem to be a large percentage of radiation of less than 5 MeV. energy, which does not agree with the shape of spectrum which has been assumed in some experiments[1]. It must be emphasized (see the discussion below) that Fig. 2(*a*) is not the spectrum that would be obtained if only the target radiation were measured.

Fig. 1(*b*) shows the histogram of 75 recoil proton tracks detected in an Ilford *C*2 Nuclear Research plate in a special camera designed and built by one of us (R. M. P.), so that the protons emitted at 30°–90° with the incident X-rays could be detected. All these tracks were found between 60° and 90°, and the histogram was corrected as shown to give the total number of tracks from 0° to 90°. This was done by finding the variation of angular distribution of the protons with energy from previous published work[9–11]. The smooth curve of Fig. 1(*b*), when corrected by Bethe's cross-section/energy curve, yielded a distribution in good agreement with that of Fig. 2(*a*) down

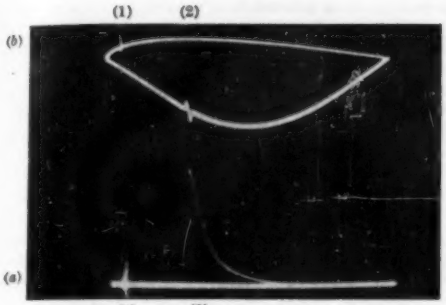


Fig. 3

to an energy of about 5 MeV., below which the proton curve fell off, possibly due to excessive adsorption of the protons in the heavy wax target. The two curves are shown together in Fig. 2(*b*) over the range 4–12 MeV. A point of interest about the two histograms is that neither pairs nor recoil protons were obtained corresponding to an X-ray energy of 7–7·5 MeV., although about five such pairs would be expected.

Although the main purpose of this note is to direct attention to the methods used, and the need for information on betatron and synchrotron spectra, it may be of interest to speculate on the shape of the curves of Fig. 2. The molybdenum target in the betatron (see Kerst[12], Fig. 2) is thin compared with the range of 20-MeV. electrons, and it appears that during the application of the expander pulse the electrons may on the average lose a little (~ 1 per cent) of their energy at the edge of the target and then oscillate about a new equilibrium orbit, arriving back at the target after several (in our case two) revolutions, then repeating the process. The amplitude of these oscillations therefore increases as the mean orbit radius decreases until the electrons bombard the inner wall of the vacuum chamber, which acts as a thick glass target from which much soft radiation may be expected. However, it should be possible for the 20-MeV. electrons to lose perhaps 10–20 per cent of their energy at the target. It is to be expected that if good collimation were used, so that only radiation arising at the target were observed, then the resulting spectrum would be of the normal *Bremsstrahlung* (thin-target) type. The present experiments are not sufficient to allow the intensities of target and wall radiation to be compared, but are described partly to direct attention to the latter.

Lasich and Riddiford[3] also found much soft radiation but suggested different explanations with which we are inclined to disagree. It is to be expected that soft radiation (probably with much less energy than, say, 2 MeV., cf. Fig. 1*b*) may arise from electrons scattered in the residual gas in the acceleration chamber soon after injection. Fig. 3*a* shows (1) a pick-up pulse due to the injector (see also Fig. 3*b*, 1) and (2) pulses, from a Geiger counter placed in the beam, which all coincide with each other (there were approximately 300 pulses in the time of exposure) at the instant of beam expansion which is shown by the pulse of Fig. 3*b*, 2, thus indicating that scattered radiation arising in the early part of the accelerating period was of negligible intensity.

The above considerations may be proved or disproved by further experiments which it is intended will be carried out. We also hope to publish a more detailed account of the work elsewhere.

We are greatly indebted to Mr. B. Touschek (University of Glasgow) and Mr. F. K. Goward (Telecommunications Research Establishment) for instructive discussions on the work.

[1] Baldwin, G. C., and Klaiber, G. S., *Phys. Rev.*, **71**, 3 (1947).
[2] Lasich, W. B., and Riddiford, L., *J. Sci. Instr.*, **24**, 177 (1947).
[3] Fowler, W. A., Gaerttner, E. R., and Lauritsen, C. C., *Phys. Rev.*, **53**, 628 (1938).
[4] Kruger, P. G., and Ogle, W. E., *Phys. Rev.*, **67**, 273 (1945), and references there cited.
[5] Heitler, W., "Quantum Theory of Radiation" (Oxford, 1944).
[6] Baldwin, G. C., and Klaiber, G. S., *Phys. Rev.*, **71**, 554 (1947).
[7] Chadwick, J., and Goldhaber, M., *Nature*, **134**, 237 (1934) and later papers.
[8] Powell, C. F., Occhialini, G. P. S., Livesey, D. L., and Chilton, L. V., *J. Sci. Instr.*, **23**, 102 (1946).
[9] Gibson, W. M., Green, L. L., and Livesey, D. L., *Nature*, **160**, 534 (1947).
[10] Chadwick, J., Feather, N., and Bretscher, E., *Proc. Roy. Soc.*, A, **163**, 366 (1937).
[11] Rarita, W., and Schwinger, J., *Phys. Rev.*, **59**, 556 (1941).
[12] Kerst, D. W., *Rev. Sci. Instr.*, **13**, 387 (1942).

EFFECT OF ION-EXCHANGE TREATMENT ON THE STABILITY OF APPLE JUICE

By Dr. S. W. CHALLINOR, MARGARET E. KIESER and Dr. A. POLLARD

Department of Agriculture and Horticulture, University of Bristol, and Research Station, Long Ashton, Bristol

ION-EXCHANGE adsorbents have come into increasing use for the de-acidification of fruit juices and extracts[1-3]. In spite of the wide application of such methods in these and related fields, as summarized by Riches[4] and by Davies[5], the effect of such treatments on the 'stability' of juices has, to the best of our knowledge, received little or no attention.

In the course of experiments on the de-acidification of apple juice, a very considerable reduction in the concentration of certain cations and anions took place, as observed by other workers. It occurred to us that such treated juices would be less able to support the growth of micro-organisms and therefore less liable to undergo fermentation. If this were so, it would be of considerable practical importance. In this connexion, Dr. A. K. Zweede of Wageningen had mentioned to us that there was evidence that sugar-beet extracts after treatment with adsorbents showed an increased stability. In our own preliminary experiments, it was found that apple juices subjected to ion-exchange treatments and then freely exposed to air showed much less fermentation than juices not so treated.

In more comprehensive tests, samples of depectinized and pulp-filtered apple juices were passed through laboratory columns of the Permutit ion-exchangers 'De-Acidite *B*' and 'Zeo-Karb *H* 1'. These treatments are summarized in the accompanying table. A marked change in juice composition was produced by the removal of cations in the 'Zeo-Karb' column, accompanied by a corresponding increase in hydrogen-ion concentration. One passage through this adsorbent reduced the total ash in the Blenheim

ION-EXCHANGE TREATMENT AND ITS EFFECT ON JUICE COMPOSITION

Juice	Treatment: 'De-Acidite D' or 'Zeo-Karb Z'	pH	Total ash as % of juice	Constituents as mgm./100 ml. juice					
				Ca	Mg	Cu	Zn	P	N
1. Blenheim Orange	nil	3·62	0·274	14·2	7·0	0·21	0·64	12·4	14·0
2. " "	Z	2·30	0·048	trace	trace	0·05	0·07	12·2	7·0
3. Rival	nil	3·53	0·334	16·9	5·4	0·11	0·81	15·0	13·6
4. "	Z	2·23	0·049	trace	trace	0·03	0·15	—	—
5. "	Z, D, Z	2·33	0·003	"	"	0·02	0·07	1·2	1·2

Orange juice (1) to 17·5 per cent and the ash in the Rival juice (3) to 14·7 per cent of the original values. A second passage of the latter juice through the regenerated column, after an intermediate treatment with 'De-Acidite' to reduce acidity, further diminished the ash to 1 per cent of its original value. As these treatments produced a significant change in *p*H, all juices tested microbiologically were first adjusted to their original *p*H by the addition of a solution of sodium hydroxide (analytical grade) in glass-distilled water.

In the initial microbiological tests, pasteurized samples of these juices were separately inoculated as follows: (*a*) with a loopful of a pure wine yeast culture—'Herrliberg'—grown for 24 hours at 25° C. in malt extract; (*b*) with a loopful of a suspension of the same yeast in glass-distilled water, prepared from a 24-hour-old streak culture on malt extract agar; and (*c*) with a loopful of a washed suspension of the mixed microflora obtained by centrifugation from the untreated juice (Rival 3) which had been kept at room temperature for a few days and was actively fermenting. Suspension (*c*) consisted mainly of yeasts, relatively few bacteria being present. Precautions were taken to avoid introducing appreciable quantities of ions either from glassware or from the inocula. Thus, the suspensions were prepared in glass-distilled water and used immediately. The inocula were large—more than 20,000 viable organisms in inocula (*a*) and (*b*), and more than twice that number in inoculum (*c*) for each 7 ml. of juice.

In the earliest experiments—on treated juices of Bramley's Seedling—in which inocula (*a*) and (*b*) only were used, a marked reduction of the growth of yeasts was observed. These encouraging results were followed by experiments on juices which had received more thorough treatment (double passage through 'Zeo-Karb'). Each juice sample was separately inoculated with inocula (*a*), (*b*) and (*c*) and incubated aerobically at 25° C. No growth of the 'Herrliberg' yeast occurred in the treated juice even after two weeks incubation. With the mixed yeast inoculum (*c*) a small deposit formed, sufficient to impart a very slight haze to the juice after vigorous shaking. That only slight multiplication of the mixed yeasts had, in fact, occurred was confirmed by microscopic examination, which showed that the amount of such multiplication was exceedingly small. Furthermore, the yeasts had not the normal healthy appearance of those growing in the untreated juice. These results were confirmed in a subsequent experiment.

The nature of the effects observed in the treated juices presents many interesting problems. We are here interested mainly in those micro-organisms able to cause fermentation, that is, the yeasts and certain bacteria; suppression of the growth of fungi, however, is also of interest. Information on the general nutritional requirements of micro-organisms is not very detailed, but it is known that, in addition to the *main* requirements of carbon, hydrogen, oxygen and nitrogen, other elements or groups are also required. Among these are the following: phosphate, sulphate, carbonate, chloride, sodium, potassium, magnesium, iron, calcium, copper, also possibly manganese, zinc, cobalt and molybdenum. It must be remembered also that the *ratios* of the concentrations of certain ions as well as their absolute quantities may be of significance.

It has not yet been possible to investigate in detail the nutritional deficiencies in our treated juices, but in preliminary analyses the elements given first attention were nitrogen, phosphorus, calcium, magnesium, zinc and copper. The reduction in total nitrogen in the treated Rival juice (3), as shown in the table, was not such as would alone be expected to explain the present findings. The ion-exchange treatments gave most significant reductions in the concentrations of total phosphorus, calcium and magnesium, the two latter being reduced to less than 1 per cent of their original values in this juice. Copper and zinc were also considerably reduced, but to a less marked extent. Spectrographic analysis of the earlier juices, made possible by the courtesy of the International Smelting Corporation, Avonmouth, confirmed the presence of calcium, magnesium, copper and zinc in the treated and untreated juices. Traces of manganese were also present, but molybdenum was not detected.

In a further series of microbiological tests the following salts (analytical grade) were added to the treated juice, either separately or in combination, in amounts comparable with those present originally: ammonium sulphate (nitrogen and sulphate), ammonium phosphate (nitrogen and phosphate), magnesium sulphate and calcium chloride. The juices were inoculated with the microflora of the Rival juice (3) and incubated at 25° C. After a *short* period of incubation (three days), appreciable growth appeared only in the juices containing both added nitrogen and phosphorus, there being no marked difference between that containing added nitrogen and phosphorus only and that receiving nitrogen, phosphorus, magnesium and calcium; growth, however, was very considerably less than in the original untreated juice. After a further three days incubation there was a marked difference between the juice receiving the four nutrients and that receiving nitrogen and phosphorus only; in fact, the amount of growth in the former was then of the same order as in the untreated juice.

The microbiological tests have been carried out aerobically. It should be borne in mind that apple juice is normally stored under conditions of restricted oxygen supply: under such conditions, however, the effects of ion-exchange treatment on juice stability would be expected to be similar or even more marked. Some evidence that this is so has been obtained from an experiment under less aerobic conditions.

We have attempted to apply these findings by storing treated and untreated juices in the laboratory

at ordinary temperatures. Although the juices were unpasteurized and no aseptic precautions were observed, the treated juice (Rival 5) showed no obvious fermentation during the period of observation (four weeks); some slight mould growth, however, occurred. Juice which had been de-aerated and bottled under carbon dioxide showed even greater stability. The untreated juice (Rival 3) was rapidly fermenting within three days.

It is thus apparent that ion-exchange treatment of apple juice effects the removal or partial removal of nutrients necessary for the growth of micro-organisms. Juices so treated become very much less liable to microbiological spoilage. Further experiments on this and other aspects of the work are in progress. If it should prove practicable to produce similar changes in juice composition affecting the growth of micro-organisms by ion-exchange treatment on a commercial scale, then the industrial production of apple juice—and possibly of other fruit juices—might be radically changed in respect of processing procedure, storage and the ultimate stability of the finished product. It is obvious also that the results here recorded open up far-reaching possibilities in connexion with the preparation and stability of other types of fruit products, for example, cider and perry.

We wish to thank the Permutit Co., Ltd., for samples of the adsorbents used in this work.

[1] Inglis and Fiess, *Ind. Eng. Chem.*, **34**, 864 (1942).
[2] Matchett, Legault, Nimmo and Notter, *Ind. Eng. Chem.*, **36**, 851 (1944).
[3] Buck and Mottern, *Ind. Eng. Chem.*, **37**, 635 (1945); **39**, 1087 (1947).
[4] Riches, *Chem. and Ind.*, **43**, 656 (1947).
[5] Davies, *Chem. and Ind.*, **4**, 51 (1948).

THE ROYAL SANITARY INSTITUTE

THE Annual Congress of the Royal Sanitary Institute was held at Harrogate this year during May 24–28. On May 28, a joint meeting was held with the Food Group of the Society of Chemical Industry to discuss the cleaning and sterilizing of plant in the food industry. After an introduction by Dr. E. B. Hughes, chairman of the Food Group, papers were presented by Dr. J. G. Davis on "The Cleaning and Sterilizing of Dairy and Ice Cream Plant", by Mr. H. J. Bunker on "The Hygiene of Beer Production and Consumption", and by Mr. D. H. F. Clayson and Mr. C. W. Chater on "The Cleaning and Sterilization of Plant and Utensils in the Food Industry".

Dr. Davis defined cleaning as the removal of all residues and particularly those which serve as a food for bacteria. Sterilization is only a finishing process, cleaning being the more important operation. Unless all food residues are removed, the few remaining bacteria can proliferate rapidly in the presence of food, moisture and warmth. A reasonable standard for commercial sterility or 'sanitization' is one colony per ml. capacity or per square centimetre of surface.

Although different methods can be used successfully, all methods conform to certain fundamental principles, which were enumerated as follows:

(1) Cleaning and sterilizing must always be regarded as distinct and different operations.

(2) The first treatment should always be a cool or tepid water rinse. Cold water hardens the fat, and hot water denatures the water-soluble proteins which with calcium salts form a strongly adhering film. Hard water should be softened.

(3) The second treatment should be with a suitable detergent solution applied as hot as possible. This emulsifies the fat and proteins, partially saponifying or hydrolysing them, and finally washes away the broken-down and loosened milk constituents. The emulsifying power of the detergent solution is related to the surface tension and to its ability to penetrate between dried-on milk film and the metal surface.

(4) Should any milkstone be visible after the detergent treatment, this must be removed by a weak acid solution, as otherwise the sterilizing will not be efficient. Milkstone does not normally form unless milk is heated, and so is found chiefly in the hot sections of pasteurizing plant. Frequency of acid treatment depends on the type and individuality of the plant, the milk supply, the time of running, the temperature used and other variable factors.

(5) 'Scale', or 'fur', resulting from the use of hard water is inimical to sterilizing, and can be particularly troublesome in bottle-washing machines. As with milkstone, the dilute acid treatment is necessary for its removal. In order to avoid corrosion, inhibitor preparations should be incorporated in the acid solution. These generally consist of organic nitrogen compounds of the quinoline type.

(6) Special precautions must be observed with certain metals, particularly aluminium and tin. Detergents for use with aluminium and tin should contain at least 25 per cent silicate, and preferably no caustic soda at all. The incorporation of about 10 per cent of sodium sulphite has been recommended to prevent corrosion of tinned plate, but this is only rarely used in Great Britain. All metals, including stainless steel ('crevice attack'), can suffer corrosion with chlorine, especially if used with soft water which has a low *p*H.

(7) After cleaning, equipment should be left either dry or in contact with the sterilizing solution. The better method is to keep thoroughly clean plant in a dry condition, as bacteria cannot grow without moisture.

In discussing dairy equipment, it was emphasized that on the farm the best results can be obtained with very simple and home-made equipment. On farms where the buildings, etc., are in very bad condition it has been shown that it is possible to produce milk of good-keeping quality provided there is a good supply of clean, cold water, and the utensils are thoroughly washed.

On the other hand, in farms with excellent buildings and the very latest and often expensive equipment, poor-keeping quality in milk is sometimes found where there is a lack of clean, cold water, and where apparently trivial but, in reality, serious mistakes are made in the cleaning and sterilizing of the equipment.

Churns are generally treated by pre-rinse, hot rinse or hot detergent, hot rinse, steam, and sometimes hot air at 240° F. The author expressed his preference for a final steaming which left the churn very hot at the mouth rather than for a final treatment by hot air. For containers which have to be emptied and cleaned quickly, a preference was expressed for a chlorine wash rather than for steam for sterilizing.

Pipelines should be taken down every day; but some dairies get satisfactory results by only stripping

every second or third day. On the Continent, plant is treated by dilute nitric acid, detergent and final rinse and only rarely taken down; but this method has not been generally adopted in Great Britain. Pasteurizing plant should be dismantled at least once every day and thoroughly cleaned and sterilized. The modern high-temperature-short-time pasteurizing plant is not susceptible to thermophilic growth as is the 'holder' plant.

Only a very small proportion of bottles are now scalded with steam or hot water. Most big dairies employ bottle-washing machines which use hot detergent at 140° F., which both cleans and sterilizes bottles. It is important, however, to maintain rinse solutions in a satisfactory bacteriological condition.

In dealing with some special aspects of problems in the dairy industry, the author emphasized the significance of the individuality of utensils, and the effect of atmospheric temperature on the bacteriological condition of utensils and plant, the importance of the interval between sterilizing and use, and further pointed out that the larger the container the smaller is the relative contamination by a given number of bacteria per unit of surface.

Hypochlorite solution used for sterilizing is sometimes used at an unnecessarily high strength, about 150 p.p.m. at a minimum temperature of 120° F. for a minimum time of 2½ minutes being recommended. Too strong a chlorine solution might lead to serious corrosion, especially when the water is soft.

Mr. H. J. Bunker, in dealing with the hygiene of beer production and consumption, briefly described stages in the making of beer. The malting of the barley is followed by the grinding of malt and mashing of the ground malt or grist. The wort is next boiled for some time and the hops added. The boiled wort is then pitched or inoculated with yeast, and fermentation allowed to proceed. The beer is finally run to cellars, where it is emptied into casks or held in a container from which, after a few days, it is bottled, with or without filtration, according to the type of beer. After bottling it may be pasteurized, but in Great Britain the greater part of the bottled beer is not heat-treated.

On account of its high acidity, beer is one of the safest of foods from the bacteriological point of view. The pH of beer is usually about 4 and this probably explains why pathogenic bacteria are always absent. In addition, hops and alcohol are factors inhibitory to bacteria. The prolonged boiling of the wort gives complete sterility at one stage, and the author was of the opinion that the maintenance of clean mains was the most important item of hygiene in the brewery. The cleaning of these mains must be a regular operation, for which caustic soda solution is commonly used.

Beer is now generally cooled in a built-in type of cooler which has the advantage that delivery is achieved in a closed system without intermediate exposure to infection.

A point of some importance in the cleaning of brewery plant, which might consist of copper, wood, slate, aluminium, stainless steel or wax-lined materials, is the fact that in course of time a deposit known as 'beerstone' forms on the side of the fermenting vessel. The modern brewer prefers to remove this beerstone and thus eliminate what would otherwise become a dangerous lurking place for micro-organisms.

Bottles and bottle-filling machines require particular attention. In bottle-washing, caustic soda is the chief constituent of the detergent, and the general standard of cleanliness in these machines is now very high.

Preservatives are not added to bottled beers, the old idea that the brewer adds chemicals to beer being entirely erroneous. The only preservative which is permitted in brewing is sulphur dioxide.

One of the chief sources of contamination in breweries is old cellar floors which, when they become cracked, are difficult to clean. Such floors can be treated with chloride of lime or 'Antiformin' (sodium hydrochlorite and sodium hydroxide). Phenolic antiseptic should not be used, for obvious reasons.

Mr. Bunker next dealt with the very important aspect of hygiene in beer houses and named three methods for dealing with the problem of glasses: (*a*) the automatic glass-washing machine; (*b*) the self-emptying sink; (*c*) the addition of some suitable detergent or antiseptic to the rinse water. He expressed a preference for the third method and described recent work on the use of quaternary ammonium compounds for this purpose.

Dealing finally with the question of drying cloths, Mr. Bunker said that most bar-tenders prefer to dry and polish glasses after rinsing. If the cloths are allowed to get dirty they may well put back on the glasses more organisms than were there before drying. It is essential that any cloths used should be in a good bacteriological condition.

Mr. Clayson and Mr. Chater, in dealing with the present-day communal feeding in restaurants and canteens, stated that the effects of inadequate hygiene in the kitchen may be serious. Although machine-washing is growing in restaurant kitchens this method is not foolproof, and in the authors' experience there is not much difference between the results of hand-washing and machine-washing.

They pointed out that dirt is not defined from the legal point of view and that it is necessary, in order to comply with the Food and Drugs Act (1938), to define processes that can be relied upon to destroy or remove pathogenic organisms if they should be present. This definition would have to be in chemical or physical terms in relation to detergent concentrations, temperatures, times, etc. With highly glazed or polished articles the appearance is a very good guide to their hygienic condition. This question is important because the removal of soiling deposits from food utensils is an important stage in securing a satisfactory hygienic condition.

Instead of stating that a certain organism is destroyed in a certain time at a certain temperature, it is preferable to refer to destruction-rates, for example, the decimal reduction time, which is the time required to reduce the count to one-tenth of what it was originally. The decimal reduction time of most intestinal organisms is of the order of one minute at 140–145° F. At 160° F. or over the decimal reduction time values of staphylococci and streptococci are a matter of seconds only.

Thermoduric organisms are of little sanitary significance. 'Sanitization' may therefore be defined as a treatment which eliminates pathogenic and food-poisoning micro-organisms but which may not destroy thermoduric organisms.

The extent of dispersion of soiling material depends upon the volume of wash water, the mechanical force applied, the volume of rinsing water and the frequency with which the washing and rinsing waters are changed. If the sterilization process consists of immersion in hot water or disinfectant solution, a satisfactory cleaning has the additional advantage

that any remaining bacteria are easily dislodged from the surface. With satisfactory washing it is possible to achieve a high degree of sterility by immersing the articles for a much shorter time in the rinse water than would be required if all the bacteria remained attached to the surface.

The United States Public Health Service Code requires: (1) a cleaning process with a detergent solution at 110–120° F.; (2) sterilization (with a choice of four methods); and (3) drying with clean cloths, or preferably by evaporation. The standards required in the United States give, apparently, a very wide margin of safety if the conditions for high-temperature-short-time pasteurization, that is, 162° F. for not less than fifteen seconds, can be taken as a guide for the destruction of pathogenic organisms. Evaporation after hot-water rinsing is preferable to drying by a cloth.

For utensils with thick or dried-on deposits, machines which allow a long period of contact with detergent solution are necessary. An important point in the design of such machines is the avoidance of excessive carry-over of the detergent solutions to the rinsing compartments.

A plant used for the preparation, service and storage of food needs the same if not more attention from the hygienic point of view than the multi-service utensils.

To obtain a bactericidal effect with steam it is essential to keep the steam in an enclosed space with a comparatively small vent and to continue steaming for at least three minutes after steam issues from the vent at over 205° F.

The authors suggested that it would be sometimes advisable to employ two different types of sterilizing treatment, for example, steam and hypochlorite solution, with the object of destroying organisms which might escape one of these treatments, but no experimental evidence was quoted in support of this view. Hypochlorite treatment must, of course, be followed by further rinsing with cold water.

WIGAN MINING COLLEGE

FOUNDED on October 27, 1857, Wigan and District Mining and Technical College has just celebrated its ninetieth anniversary. In its first session the average attendance was 15; now it has some 2,800 students. The intervening ninety years show a continuous record of expansion and progress in spite of many difficulties. Like most higher institutions of learning in Britain to-day, the College is overcrowded and badly in need of extended accommodation and additional facilities, particularly for postgraduate and research work. Founded primarily to develop mining education, and still maintaining a leading position in that field, it has never confined itself to mining alone. Its range of work covers also engineering, chemistry, physics, geology, biology, mathematics, building, commerce, economics, art, and other subjects.

A special feature of the work of the College is the provision of complete full-time courses for the degrees of the University of London in mining, engineering, general science, chemistry, physics, geology, mathematics and economics. The College is inspected and recognized by the University in connexion with the mining and engineering degree courses. It is also recognized by the Board for Mining Examinations, the Board of Trade, the Institution of Civil Engineers, the Institution of Mining Engineers, the Royal Institute of Chemistry, the Institute of Physics, etc. It is the headquarters of the Manchester Geological and Mining Society and provides accommodation for meetings of many other scientific, technical and professional bodies. A notable feature of its work is the development of its library and refectory services and of student activities. It has in Christopher Park one of the finest athletic grounds in the north of England.

A meeting to celebrate the ninetieth anniversary was held in the College hall on June 7. This was attended by a very representative gathering, including educationists, scientific workers, industrialists, and government and local officials, as well as governors, staff and students. The chairman of the Governing Body, Colonel J. S. A. Walker, presided, and the principal, Dr. J. F. S. Ross, gave a brief survey of the history and work of the College, directing attention to the devoted service it had received from its founders and their successors, its long-standing regional character and independence—it receives very substantial grants from the Lancashire and Wigan Education Authorities but possesses its own freehold land and buildings and has its own autonomous governing body—and to the development within it of a truly educational and collegiate spirit. The chairman of the General Purposes Committee, County Councillor A. Guest, who has been a governor of the College for the last third of a century, also referred to aspects of its history and directed attention to its high reputation at home and abroad. Notwithstanding the invaluable help of local authorities, the College needs greater financial resources, and he thinks it should receive these on lines comparable with those on which university colleges are helped by the University Grants Committee.

Sir Charles Ellis, scientific member of the National Coal Board, gave an address on "The Place of Science in a Technical Training". After commenting on the high reputation of the College in science and industry—he had heard from everyone in a position to judge that Wigan-trained people had a sound knowledge of and lively interest in the fundamental sciences and a genuine appreciation of the means of applying them to technological problems—Sir Charles referred to the distinction between industrial scientists and research scientists, and denied the validity of any difference of status between them. He mentioned the manifold duties of scientific men in connexion with the National Coal Board: while the majority of them are in the colliery chemical services and carry out their scientific duties in daily contact with industry, there are other groups which have more national standing. He mentioned the special group dealing with the survey of coal seams in Britain, and said that we have an accurate knowledge of the quality of our coal seams for many years ahead before they are mined. He also referred to the research group engaged on fundamental studies of coal substance. These are doing pioneer work. He went on to develop a closely reasoned argument as to the intrinsic value of scientific education, not only in relation to industry but also in inculcating a genuinely philosophical attitude to life. The address is to be published by the College in pamphlet form.

An illustrated booklet on the College has been issued in connexion with the ninetieth anniversary; copies can be obtained from the College office, price 1*s.* 6*d.* each.

FORTHCOMING EVENTS

Wednesday, June 30

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 2.30 p.m.—Annual General Meeting.

Friday, July 2

PHYSICAL SOCIETY (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. J. Hamilton: "The Theory of Radiation Damping": Mr. R. M. Sillitto: "An Extension of Kapitza's Theory of δ-Radiation".

GEOLOGISTS' ASSOCIATION (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Sir Arthur Russell, Bart.: "Early British Mineral Collectors and Mineral Collecting".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ANATOMY, preferably with some experience in Histology—The Secretary, The University, Aberdeen (July 3).

LECTURER IN EDUCATION—The Secretary, The University, Edmund Street, Birmingham 3 (July 3).

LECTURER IN PHYSICS up to B.Sc. standard—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (July 3).

ASSISTANT AGRICULTURAL ECONOMISTS (2), and a LECTURER IN AGRICULTURAL ECONOMICS—The Registrar, King's College, Newcastle-upon-Tyne (July 3).

LECTURER IN STATISTICS in the Department of Economics and Social Science—The Registrar, University College of South Wales, Cardiff (July 5).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BOTANY, a DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY, and a SECOND DEMONSTRATOR IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 5).

LECTURER IN PHYSIOLOGY, an ASSISTANT LECTURER IN GEOGRAPHY, and TUTORIAL STUDENTSHIPS IN BOTANY, HISTORY, MATHEMATICS, PHYSICS and ZOOLOGY—The Registrar, King's College, Strand, London, W.C.2 (July 5).

ST. MUNGO (NOTMAN) CHAIR OF PATHOLOGY—The Secretary of University Court, The University, Glasgow (July 7).

LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—The Secretary, The University, Edinburgh (July 15).

RESEARCH OFFICER IN THE DIVISION OF PLANT INDUSTRY, Canberra—The Secretary, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1740 (July 17).

PRINCIPAL RESEARCH OFFICER or SENIOR PRINCIPAL OFFICER (Ref. No. 1749), and RESEARCH OFFICERS (3, Ref. No. 1750), in the Division of Economic Entomology, Canberra—The Secretary, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 17).

RESEARCH OFFICER IN THE SOUTH AFRICAN NATIONAL PHYSICAL LABORATORY, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (July 19).

CHAIR OF CHEMISTRY—The Secretary, The University, Aberdeen (July 31).

LIBRARIAN in the Department of the Scientific Adviser to the Army Council at the War Office, a LIBRARIAN and ASSISTANT LIBRARIANS (2) at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2183 (July 31).

PRINCIPAL SCIENTIFIC OFFICER (responsible for advising commercial undertakings and hospitals as to the application of radioactive isotopes, and for the scientific planning for production of isotopes in close association with chemical and nuclear physics research groups), a PRINCIPAL SCIENTIFIC OFFICER (to lead a Physics Production Group for radioactive isotopes and responsible for the irradiation of materials, their standardization and packing), a SENIOR EXPERIMENTAL OFFICER (responsible for implementing processes evolved by a research group for production of radioactive isotopes and to head a group of chemists engaged on routine isotope production), and EXPERIMENTAL OFFICERS (2, responsible for routine testing, packing and dispatch of radioactive material), at the Atomic Energy Research Establishment of the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2185 (July 31).

PROFESSOR OF ORGANIC CHEMISTRY, and a PROFESSOR OF THEORETICAL PHYSICS—The Registrar, Indian Association for the Advancement of Science, 210 Bowbazar Street, Calcutta 12, India (August 1).

SCIENTIFIC ASSISTANT for the collation, abstracting and reviewing of biological literature—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (August 1).

HEADS OF THE DEPARTMENTS OF (*a*) ARCHITECTURE AND TOWN AND REGIONAL PLANNING, (*b*) CIVIL AND SANITARY ENGINEERING, (*c*) ELECTRICAL ENGINEERING, (*d*) MECHANICAL ENGINEERING, (*e*) CHEMICAL ENGINEERING, (*f*) GEOLOGY AND GEOPHYSICS, (*g*) NAVAL ARCHITECTURE AND MARINE ENGINEERING, and (*h*) TEXTILE TECHNOLOGY, in the proposed Eastern Higher Technical Institution near Calcutta—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 396W (August 20).

DIRECTOR of the proposed Eastern Higher Technical Institution near Calcutta—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 403W (August 20).

ENTOMOLOGIST to carry out a survey of the tsetse areas of the Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist'.

LABORATORY TECHNICIAN to take charge of the Physics workshop—The House Governor, Queen Elizabeth Hospital, Birmingham 15.

LABORATORY ASSISTANT (male) IN THE DEPARTMENT OF CHEMISTRY—The Steward, Department of Chemistry, The University, Manchester.

LABORATORY ASSISTANT (Grade B 1) for general laboratory and histological routine—The Professor, Department of Human Anatomy, The University, Oxford.

STUDENT TECHNICIAN FOR BACTERIOLOGICAL DEPARTMENT—The Secretary, University College Hospital, Gower Street, London, W.C.1.

METEOROLOGISTS in the Meteorological Service of the Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Meteorologists'.

SENIOR CROP RECORDER—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

PROFESSOR OF PHYSICS AND ELECTRICAL ENGINEERING at the Royal Naval College, Greenwich—The Director (P.A.), Education Department, Admiralty, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Agriculture and Fisheries. Bulletin No. 139: Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1943–1946. By W. C. Moore. Pp. vi+90+12 plates. (London: H.M. Stationery Office, 1948.) 2s. 6d. net. [115

Scottish Zoo and Wild Life. (The Magazine of the Zoological Society of Scotland.) Quarterly. Vol. 1, Part 1, April. Pp. 48+9 plates. (Edinburgh: Oliver and Boyd, Ltd., 1948.) 3s. net; annual subscription, 12s. [115

National Forest Park Guides. Snowdonia. (Issued by H.M. Forestry Commission.) Pp. 72. (London: H.M. Stationery Office, 1948.) 2s. 6d. net. [115

Forestry Commission. Empire Forests and the War: Statistics prepared for the Fifth British Empire Forestry Conference, Great Britain, June 1947. Pp. ii+18. (London: H.M. Stationery Office, 1948.) 1s. net. [115

British Intelligence Objectives Sub-Committee. Overall Report No. 2: Shipbuilding and Marine Engineering in Germany during the Period 1939–1945. Prepared by F. J. C. Jacob. Pp. 20. (London: H.M. Stationery Office, 1948.) 6d. net. [125

Commonwealth Economic Committee. Industrial Fibres: a Summary of Figures of Production, Trade and Consumption relating to Cotton, Wool, Silk, Flax, Jute, Hemp, Mohair, Coir and Rayon. Compiled in the Intelligence Branch of the Commonwealth Economic Committee. Pp. 137. (London: H.M. Stationery Office, 1948.) 5s. net. [125

Other Countries

Sugar Research Foundation, Inc. Technological Report Series No. 4: Use of Molasses in Grass Silage Preparation. By Prof. Carl B. Bender. Pp. v+22. (New York: Sugar Research Foundation, Inc., 1948.) Free. [115

University of Illinois Engineering Experiment Station. Bulletin Series No. 369: Studies of Highway Skew Slab-Bridges with Curbs. Part 1, Results of Analyses. By Vernon P. Jensen and John W. Allen. Pp. 62. 75 cents. Bulletin Series No. 370: The Illinois Smokeless Furnace. By Prof. Julian R. Fellows, Prof. Alonso P. Kratz and Prof. Seichi Konzo. Pp. 78. 75 cents. Bulletin Series No. 371: Rate of Propagation of Fatigue Cracks in 12-Inch by ½-Inch Steel Plate with Severe Geometrical Stress-Raisers. By Prof. Wilbur M. Wilson and James L. Burke. Pp. 14. 35 cents. Bulletin Series No. 372: The Effect of Non-Uniform Distribution of Stress on the Yield Strength of Steel. By Dimitry Morkovin and Omar Sidebottom. Pp. 72. 50 cents. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1947.) [125

University of Illinois Engineering Experiment Station. Circular Series No. 52: The Railroad Dynamometer Car of the University of Illinois and the Illinois Central Railroad. By Assoc. Prof. John E. Tuthill. Pp. 34. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1947.) 20 cents. [125

Revista del Museo de Historia Natural de Mendoza. Vol. 1, No. 1, Diciembre 31, 1947. Pp. 64. (Mendoza: Museo de Historia Natural, 1947.) [136

University of Illinois Engineering Experiment Station. Bulletin Series No. 374: The Free Surface Around, and Interference between, Gravity Walls. By Prof. Harold E. Babbitt and David H. Caldwell. Pp. 58. 50 cents. Bulletin Series No. 375: Studies of Slab and Beam Highway Bridges, Part 2, Tests of Simple-Span Skew I-Beam Bridges. By Prof. Newark M. Newmark, Asst. Prof. Chester P. Siess and Warren M. Peckham. Pp. 60. 50 cents. Bulletin Series No. 376: Highspeed Freight Train Resistance, its Relation to Average Car Weight. By Assoc. Prof. John K. Tuthill. Pp. 77. 50 cents. Bulletin Series No. 377: Flexural Fatigue Strength of Steel Beams. By Prof. Wilbur M. Wilson. Pp. 32. 20 cents. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1948.) [136

Catalogues

Botany, Birds, Sea-Life, Geology, Butterflies, Moths and Scientific Voyages round the World. (Catalogue No. 689.) Pp. 62. (London: Francis Edwards, Ltd., 1948.)

Medieval Literature: Literature and History, Philosophy and Theology, Science and Medicine. (Catalogue 9.) Pp. 88. (New York: Herbert Reichner, 34 East 62nd Street, 1948.)

Johnson Matthey Products and Services. (Publication No. 1000.) Pp. ii+30. (London: Johnson, Matthey and Co., Ltd., 1948.)

Gold—Engineering Properties and Uses. (Publication No. 2020.) Pp. 12. (London: Johnson, Matthey and Co., Ltd., 1948.)

Towers Laboratory News. No. 5 (Special B.I.F. edition). Pp. 117–164. (Widnes: J. W. Towers and Co., Ltd., 1948.)

Murfume Azobenzene Smokes for Horticultural Use. Pp. 4. (Wheathampstead: Murphy Chemical Co., Ltd., 1948.)

Plant Protection Overseas Review. Vol. 1, No. 1, May 1948. Pp. 36. (London: Plant Protection, Ltd., 1948.)